NAME: Ciba Geigy
I.D. NO.: RID001194323
FILE LOC.: R-9
OTHER:

Stabilization Investigation

Former CIBA-GEIGY Facility
Cranston, Rhode Island

Final Stabilization Design Documents
Operational Performance Standards/Performance Monitoring
Shut-Down Criteria/Confirmatory Sampling Plan
Project Management

Prepared For:
CIBA-GEIGY Corporation
444 Sawmill River Road
Ardsley, New York 10502

Prepared By:
Woodward-Clyde Consultants
201 Willowbrook Boulevard
Wayne, New Jersey 07470

Volume 1 of 4

June 1994
Project No. 87X4660D

REC'D 6-16-94
F.B.

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June 1994
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SECTION 1

1.0
INTRODUCTION

1.1 OVERVIEW

These Final Stabilization Design Documents (FSDD) present the work performed during the design phase of the stabilization investigation being conducted at the former CIBA-GEIGY Corporation facility in Cranston, Rhode Island. This chapter presents background information and the organization of the FSDD in four sections:

- Section 1.2 presents background information on the facility, the project, and the stabilization investigation;
- Section 1.3 presents the objectives of the stabilization investigation;
- Section 1.4 presents the contents and organization of the FSDD; and
- Section 1.5 summarizes this chapter.

1.2 BACKGROUND

This section reviews briefly the histories of the facility, the project, and the stabilization investigation. More detailed information on the histories of the facility and the project was presented in Chapter 1 of the Phase I Interim Report (submitted in November 1991).

1.2.1 History of the Facility

The Alrose Chemical Company manufactured chemicals at the site starting in 1930. After the GEIGY Chemical Company of New York purchased the facility in 1954 and merged with the Ciba Corporation in 1970, the facility was used for batch manufacturing of organic chemicals. Agricultural products, leather and textile auxiliaries, plastics additives, optical brighteners, pharmaceuticals, and bacteriostats were manufactured at the facility. By May 1986, CIBA-GEIGY had ceased chemical manufacturing operations at the facility and had begun decommissioning and razing the plant.

The site is divided into three study areas - the Production Area, the Waste Water Treatment Area, and the Warwick Area. The boundaries of these three areas are shown in Figure 1-1. The Pawtuxet River (an off-site area) runs through the facility. Twelve solid waste management units (SWMUs) and two areas of concern (AOCs) were identified at the site. For completeness, CIBA-GEIGY identified two additional areas of investigation (AAOIs); based on the Phase I results, AAOI-16 has been designated as SWMU-16. The locations and the Media of Concern to be sampled in each of these SWMUs, AOCs, and AAOIs are shown in Figure 1-1. Additional details about these SWMUS, AOCs, and AAOIs were presented in Chapter 1 of the Phase I Interim Report and are summarized in Table 1-1.

1.2.2 History of the Project

A draft Administrative Order of Consent (hereafter simply called the "Order") requiring a RCRA Corrective Action Study at the facility was issued to CIBA-GEIGY on 30 September 1988. After negotiations and evaluation of public comments, the Order was signed by CIBA-GEIGY on 9 June 1989 and became effective on 16 June 1989. In 1987, USEPA conducted the Facility Assessment to identify known and/or suspected releases at the facility requiring further action. The results were presented in the Final RFA Report, CIBA-GEIGY RCRA Facility Assessment (January 1988). In 1988, CIBA-GEIGY conducted a Preliminary Investigation (not required by the Order) to begin characterizing the facility's environment and selected releases; the results were summarized in the Current Assessment Summary Report.

The RCRA Facility Investigation will characterize the impact of known and/or suspected releases that were determined by the Facility Assessment to require further action. The Facility Investigation is being conducted in two phases; Phase I was conducted in two parts (Phases IA and IB) to obtain additional guidance from USEPA throughout the project. Phase IA was conducted in late 1989 and mid-1990 to characterize the facility's physical environment more completely; the results of Phase IA were presented in the Phase IA Report (October 1990).

Phase IB was conducted in late 1990 and early 1991 to characterize the impact of known and/or suspected releases at the facility more completely and to provide additional information about the facility's physical environment.

The Phase I Interim Report (November 1991) presented the results of Phases IA and IB. In particular, the Phase I results indicated that constituents are present in the groundwater in the Production Area and in the soil in SWMU-11. Because the risk assessment has not yet been conducted, no imminent threat to human health or the environment has been determined. Phase II activities began after the USEPA approved the Phase II Proposal. The deliverables for Phases II and IV (the RFI Report and Corrective Measures Study Report) will be combined and submitted on September 15, 1995. The Corrective Measures Proposal (Phase III Deliverable) will not be prepared (as agreed with USEPA on November 22, 1993).

1.2.3 History and Phases of the Stabilization Investigation

Stabilization is an approach for controlling releases at selected RCRA facilities; it is intended to prevent or minimize further migration of contaminants while long-term corrective action remedies are evaluated. The USEPA envisions that stabilization measures will be identified and implemented under the interim measures authority with the ongoing Facility Investigation activities.

In April 1992, the possibility of taking a stabilization approach at the facility was discussed in a meeting with the USEPA; in early May, the USEPA and CIBA-GEIGY agreed to pursue a stabilization investigation in the Production Area at the facility. The stabilization investigation was integrated into the RCRA Facility Investigation through a Modification of the Order executed on 28 September 1992. The Stabilization Work Plan was submitted to the USEPA in September 1992; conditional approval of the work plan was granted on 21 December 1992.

Overall, this stabilization investigation involves three phases:

1. Investigation, including developing the Stabilization Work Plan, conducting field work, and reporting the results of the field work in the Stabilization Investigation Report;

2. Design, including developing the Design Concepts Proposal (submitted to USEPA in May 1993 along with the Stabilization Investigation Report), developing the Draft Stabilization Design Documents (submitted to USEPA in November 1993), and preparing these Final Stabilization Design Documents.

3. Implementation, including permitting, construction, start-up and operation of the proposed capture and treatment systems. The Stabilization Report(s) will be developed and submitted after the performance standards for stabilization have been met.

1.3 OBJECTIVES OF STABILIZATION

This section reviews the overall objectives of the stabilization investigation and describes the objectives and scope of the design phase of the stabilization investigation.

1.3.1 Objectives of the Stabilization Investigation

The three phases of the stabilization investigation are designed to meet the following two objectives:

1. Prevent or minimize contaminated groundwater in the Production Area from migrating into the Pawtuxet River.

2. Reduce concentrations of volatile organic compounds in the soil (unsaturated zone) and groundwater (saturated zone) at SWMU-11.

1.3.2 Objectives and Scope of the Design Phase

The design phase of the stabilization investigation has two objectives:

1. Based on the results of the aquifer and treatability tests, design an effective groundwater capture and pretreatment system for the Production Area.

2. Based on the results of the dual-phase extraction pilot program (for both the aqueous and vapor phases) at SWMU-11, design a full-scale soil vapor extraction (SVE) system for SWMU-11.

In general, the scope of the design phase includes developing detailed design drawings and technical specifications for: the groundwater capture system, the groundwater pretreatment system, and the SVE system at SWMU-11.

1.4 ORGANIZATION OF THIS DOCUMENT

The FSDD is presented in four volumes:

- A summary of the functional description for each system operation is presented in Chapter 2 of this document.

- Operational performance standards for the three stabilization systems are presented in Chapter 3 of this document;

- Shut-down criteria/confirmatory sampling plans are presented in Chapter 4 of this document;

- Technical specifications (Divisions 1 through 16) are presented in Volume 2;

- A preliminary operation and maintenance (O&M) manual is presented in Volume 3; and

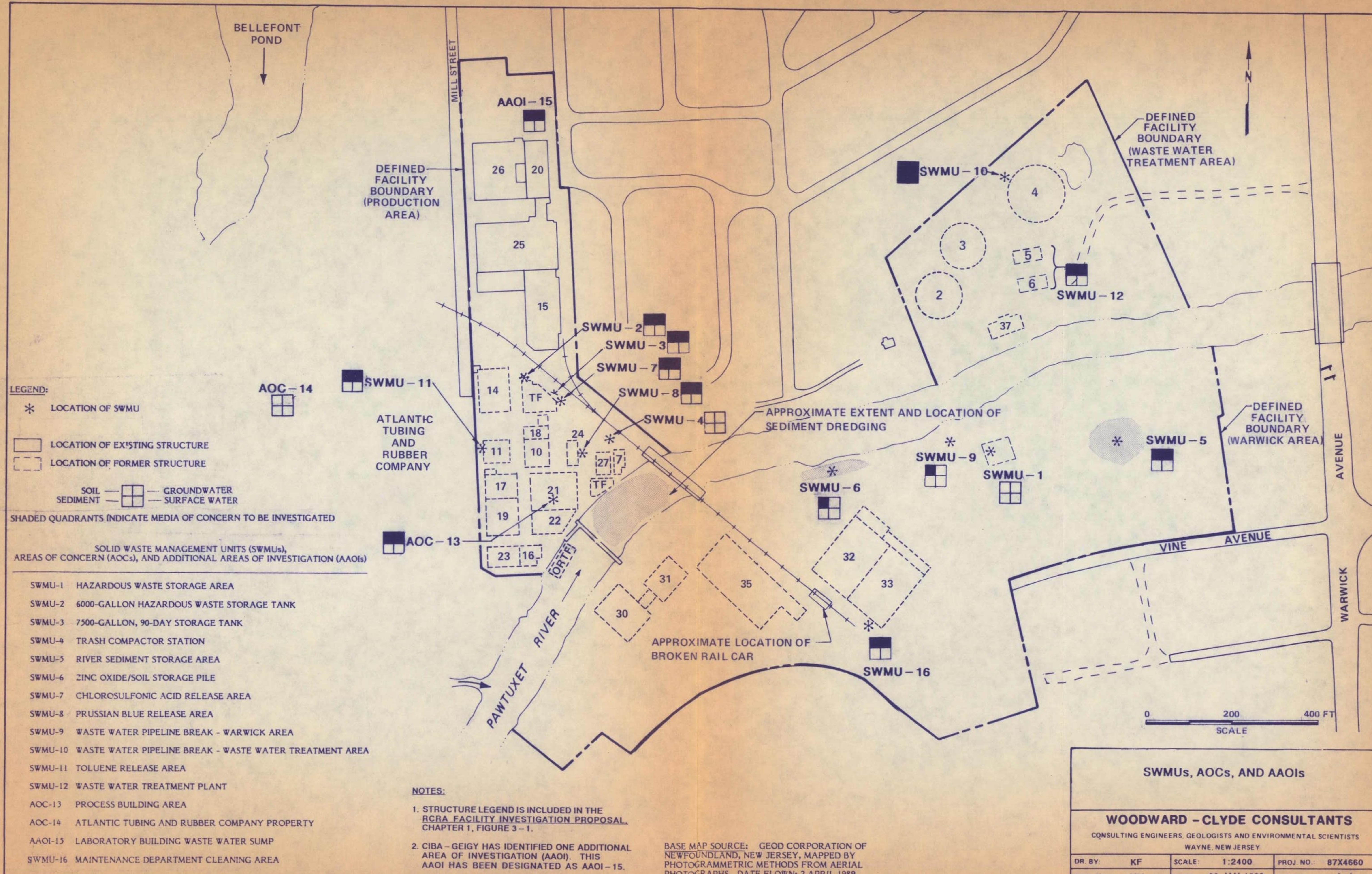
- Detailed design drawings are presented in Volume 4.

1.5 SUMMARY

This chapter reviewed the background about the stabilization investigation and described the contents and organization of the FSDD. Stabilization is an approach for controlling releases at selected RCRA facilities and is intended to prevent or minimize further migration of contaminants while long-term corrective action remedies are evaluated. In early May 1992, the USEPA and CIBA-GEIGY agreed to pursue a stabilization investigation in the Production Area at the former Cranston facility. The stabilization investigation was integrated into the RCRA Facility Investigation through a Modification of the Order executed on 28 September 1992. The stabilization investigation involves 1) investigation-conducting field work, and reporting the results of the field work in the Stabilization Investigation Report, 2) development of the Draft Stabilization Design Documents and after responding to USEPA's comments, producing the Final Stabilization Design Documents, and 3) implementation of the capture and treatment systems.

The FSDD includes four volumes. Operational performance standards and confirmatory sampling plans are presented in Chapters 3 and 4 of Volume 1, respectively. Technical specifications are presented in Volume 2. The preliminary operation and maintenance (O&M) manual is presented in Volume 3, and detailed design drawings are presented in Volume 4.

The next chapter presents the functional description for the stabilization systems.



LEGEND:

* LOCATION OF SWMU

LOCATION OF EXISTING STRUCTURE

LOCATION OF FORMER STRUCTURE

SOIL — GROUNDWATER
SEDIMENT — SURFACE WATER

SHADED QUADRANTS INDICATE MEDIA OF CONCERN TO BE INVESTIGATED

SOLID WASTE MANAGEMENT UNITS (SWMUs), AREAS OF CONCERN (AOCs), AND ADDITIONAL AREAS OF INVESTIGATION (AAOIs)

SWMU-1	HAZARDOUS WASTE STORAGE AREA
SWMU-2	6000-GALLON HAZARDOUS WASTE STORAGE TANK
SWMU-3	7500-GALLON, 90-DAY STORAGE TANK
SWMU-4	TRASH COMPACTOR STATION
SWMU-5	RIVER SEDIMENT STORAGE AREA
SWMU-6	ZINC OXIDE/SOIL STORAGE PILE
SWMU-7	CHLOROSULFONIC ACID RELEASE AREA
SWMU-8	PRUSSIAN BLUE RELEASE AREA
SWMU-9	WASTE WATER PIPELINE BREAK - WARWICK AREA
SWMU-10	WASTE WATER PIPELINE BREAK - WASTE WATER TREATMENT AREA
SWMU-11	TOLUENE RELEASE AREA
SWMU-12	WASTE WATER TREATMENT PLANT
AOC-13	PROCESS BUILDING AREA
AOC-14	ATLANTIC TUBING AND RUBBER COMPANY PROPERTY
AAOI-15	LABORATORY BUILDING WASTE WATER SUMP
SWMU-16	MAINTENANCE DEPARTMENT CLEANING AREA

NOTES:

1. STRUCTURE LEGEND IS INCLUDED IN THE RCRA FACILITY INVESTIGATION PROPOSAL, CHAPTER 1, FIGURE 3 – 1.
2. CIBA – GEIGY HAS IDENTIFIED ONE ADDITIONAL AREA OF INVESTIGATION (AAOI). THIS AAOI HAS BEEN DESIGNATED AS AAOI – 15.

BASE MAP SOURCE: GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY, MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989

SWMUs, AOCs, AND AAOIs

WOODWARD – CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY:	KF	SCALE:	1:2400	PROJ. NO.:	87X4660
CK'D BY:	MH	DATE:	20 JAN 1992	FIG. NO.:	1-1

Section 2

2.0
FUNCTIONAL DESCRIPTION

2.1 OVERVIEW

This functional description describes the control philosophy of the three stabilization systems. Only an executive summary of the functional description is presented here. The complete functional description is presented in Volume 3 (Operation and Maintenance Manual) of the FSDD. Descriptions of the three stabilization systems are provided below. Process flow diagrams for the groundwater capture system, groundwater pretreatment system, and the soil vapor extraction (SVE) system are presented in Figures 2-1 through 2-3, respectively.

2.2 GROUNDWATER CAPTURE SYSTEM

The groundwater capture system is designed to minimize the migration of contaminated groundwater from the Production Area to the Pawtuxet River. This will be accomplished by lowering the water level near the bulkhead in the Production Area below the groundwater level present beneath the river so that a reversed hydraulic gradient is developed and maintained. The groundwater capture system will include up to four recovery wells to reverse the hydraulic gradient.

The design of the groundwater capture system is based on the results of the aquifer testing program (Stabilization Investigation Report and Design Concepts Proposal, May 1993). The groundwater capture system currently includes two recovery wells PW-110, PW-120 with expansion for two additional recovery wells, PW-130, and PW-140. Figure 2-4 shows the locations of the existing and proposed wells. The groundwater capture system was designed to capture constituents in groundwater, produce sufficient drawdown to reverse the hydraulic gradient along the bulkhead, and minimize the vertical migration of constituents into the deeper strata.

Recovery wells PW-110 and PW-120 were installed in July, 1993. Proposed recovery wells PW-130 and PW-140 will be installed if additional drawdown is required along the bulkhead. Each of the recovery wells will consist of a 6-inch diameter stainless steel screen, risers and a submersible pump. Well construction details for both the existing and proposed recovery wells are presented in Appendix A.

To ensure that the required hydraulic gradient reversal is maintained, water levels in selected in-river and Production Area monitoring wells/piezometers will be monitored with several local programmable logic controllers (PLCs). The static water level in the in-river monitoring wells (located on the river side of the bulkhead) will be compared to its respective Production Area well to determine the hydraulic gradient. A differential static water level of up to two-feet will be maintained along the bulkhead automatically by the PLC. Differences in water level elevations between the in-river well and its corresponding Production Area monitoring well/piezometer will result in an adjustment of the flowrate from the recovery wells by the PLC.

Water levels in the recovery wells will be monitored by the PLC to control the pumping rate and monitor drawdown. The recovery well PLCs will be linked to the main PLC control system located in the control room. The recovery well PLC, motor-starter, instrumentation, and associated piping/valves will be housed in a small pre-engineered structure around the well. The discharge from each recovery well will be conveyed to the groundwater pretreatment system via a common header and forcemain.

2.3 GROUNDWATER PRETREATMENT SYSTEM

The groundwater pretreatment system is designed to remove metals and volatile organic compounds (VOCs) from the groundwater. The groundwater pretreatment system consists of aqueous-phase treatment; vapor-phase treatment; and sludge handling/dewatering.

2.3.1 Aqueous-Phase Treatment

Groundwater pumped from both the groundwater capture system and soil vapor extraction (SVE) system will be pretreated on-site prior to discharge. Equalization will be provided to minimize the fluctuations in groundwater flow and contaminant loading to the pretreatment system. Two equalization tanks will be provided for this system. Equalization Tank No. 1 will be provided for groundwater extracted by the groundwater capture system, while Equalization Tank No. 2 will be provided for the groundwater extracted by the soil vapor extraction (SVE) system. Agitators will be provided in both equalization tanks to prevent short-circuiting.

The equalized groundwater will be combined and pumped to the oxidation and deaeration/pH adjustment tanks. Dissolved ferrous iron in the groundwater will be oxidized with air to the less soluble ferric iron form. A low-pressure centrifugal blower will provide the air required for oxidation. As the conversion occurs, the pH of the groundwater will drop slightly as a result of hydrogen ion production. Adjustment of the groundwater pH will take place automatically using sodium hydroxide (NaOH).

A back-up chemical oxidation system will also be provided using hydrogen peroxide (H_2O_2) as the oxidant. Should the primary air oxidation system shut down, the chemical additional system will be started by the PLC control system.

The deaeration pH adjustment tank will allow small air bubbles entrained on the metal sludge particles (during air-oxidation) to be released, thus improving the sludge settling characteristics. A separate pH adjustment system will be provided in this tank to adjust the groundwater pH, if required. Following deaeration, the groundwater will be conveyed by gravity to the inclined plate separator.

An inclined-plate separator will be provided to remove the metal precipitates formed during the air-oxidation process. A flash mixing zone, flocculation zone, and gravity settling zone will be provided in the plate separator. High molecular weight anionic polymer will be added to the flash-mix zone of the separator to enhance flocculation. The insoluble metal floc formed in the flocculation zone will settle to the bottom of the separator's internal sludge thickener. Excess sludge will be transferred to the sludge holding tank at selected intervals. A portion of the settled sludge will be pumped to the oxidation tank to enhance the floc formation. The supernatant from the separator will exit from the top of the inclined-plate separator and flow by gravity to the sand filter.

A continuous backwashing sand filter will be added to remove any residual suspended solids in the overflow from the inclined-plate separator prior to the air stripper. As the groundwater flows upwards through the sand bed, residual suspended solid particles will be trapped in the filter media. A compressed air source will provide a continuous air scour to clean the sand. The reject water from the sand filter will flow by gravity to Lift Station No. 3, where it will be pumped to Equalization Tank No. 1.

Three (3) intermediate lift stations will be utilized to convey the groundwater through the pretreatment system. Lift Station No. 1 will pump groundwater from the sand filter to the air stripper while Lift Station No. 2 will pump groundwater from the bottom of the air stripper to the aqueous-phase activated carbon units. Lift Station No. 3 will be used to convey the sand filter reject water, sludge holding tank overflow and floor drains to Equalization Tank No. 1. All three lift stations will consist of a wet-well and two transfer pumps. Automatic flow control valves will be provided on Lift Stations No. 1 and 2. The automatic flow control valves will be "linked" (via the PLC controller) with the main transfer pumps on Equalization Tanks No. 1 and 2. Any change in flow from the main transfer pumps will automatically result in an adjustment of all other flow control valves. A small agitator will be added to Lift Station No. 3 to prevent solids from settling in the wet-well.

A down-flow countercurrent air stripper will be used to remove the VOCs from the groundwater. Air for the stripper will be supplied by a separate low-pressure blower. Groundwater will be pumped to the air stripper from Lift Station No. 1. An in-line organic analyzer will be provided to control the amount of groundwater flow to the air stripper. As organic concentrations in the groundwater increase, flow to the stripper will be automatically reduced, thus increasing the effective air-to-water ratio to the air stripper and improving its removal efficiency. Differential pressure in the air stripper will also be monitored to indicate possible fouling of the unit from iron or other compounds.

Following air stripping, aqueous-phase activated carbon will be provided to remove any residual organic compounds. Two backwashable activated carbon units will be provided in parallel. Backwashing operations will be manually initiated. Backwashing will be performed on a regular schedule, about once per month. During backwashing, the carbon bed will be expanded using city water. Water from backwashing operations will flow directly to Equalization Tank No. 1. When the capacity of the carbon unit has been exhausted, carbon replacement will be performed.

A final pH control system will be provided to adjust the pH of the effluent before being discharged to the City of Cranston sanitary sewer. Sulfuric acid (H_2SO_4) will be used to reduce the pH of the groundwater.

2.3.2 Vapor-phase Treatment

Saturated air containing VOC's from air stripping (and several process tanks in the pretreatment system) will be treated using vapor-phase activated carbon for organics removal (and odor control) prior to discharge to the atmosphere. A gas-fired inline dehumidifier will be provided prior to the vapor-phase activated carbon unit to reduce the relative humidity of the air, thus increasing the efficiency of the carbon. Space for two vapor-phase activated carbon units will be provided; however, only one unit will be in operation at any one time. Once breakthrough of the carbon bed occurs, the unit will be replaced. Treated air will be discharged to the atmosphere directly from the top of the carbon vessel.

2.3.3 Sludge Handling/Dewatering System

A sludge holding tank will be provided to store excess sludge and reduce the number of sludge dewatering operations. The sludge tank will have a 45° cone bottom to allow the sludge to thicken further before being pumped to the filter press. Excess supernatant from the sludge holding tank will be allowed to flow by gravity to Lift Station No. 3 where it will be pumped back to Equalization Tank No. 1 for treatment.

Sludge generated during groundwater pretreatment will be dewatered using a recessed plate filter press. The sludge will be dewatered to a dry solids concentration of between 20 and 30 percent. The sludge cake will be disposed of off-site. All sludge dewatering operations will be initiated manually and then allowed to proceed automatically. Filtrate from dewatering operations will flow by gravity to Lift Station No. 3 and be pumped to Equalization Tank No. 1.

2.4 SOIL VAPOR EXTRACTION (SVE) SYSTEM

The SVE system is designed to remove VOCs from both the soil and groundwater in the SWMU-11 area. The SVE system consists of a soil vapor and groundwater extraction system and an air phase treatment system.

2.4.1 Soil Vapor/Groundwater Extraction System

The SVE system includes seven extraction wells in the SWMU-11 area. These well locations are shown in Figure 2-5. Wells VE-1, VE-2, VE-3 and VE-11 are designed to extract both soil vapor and groundwater. Wells VE-7, VE-9, VE-10 are designed to extract groundwater only. Six additional observation wells will be used to monitor the influence of the dual-phase extraction and groundwater extraction system. These additional monitoring wells (VE-4, VE-5, VE-6, VE-8, MW-4S and P-4S) are shown also in Figure 2-2.

Each extraction well will be connected to the water and vapor extraction manifolds. A liquid level sensor at each well will be used to control automatically the water and vapor extraction manifold solenoid valves. A local PLC will be provided for the SVE system. The local SVE PLC will be integrated with the main PLC control system. Most of the SVE equipment will be installed in a trailer located near SWMU-11. The trailer will be partitioned into two zones for electrical classification purposes; one will be classified hazardous (Class 1, Division 1, Group D), the other will be classified non-hazardous. A sealed partition wall will be provided to separate the two zones.

Soil vapor and groundwater will be extracted independently from each of the four dual-phase extraction wells. A positive-displacement, lobe-type vacuum blower will be used to extract soil vapor from the extraction wells and transfer it to the thermal/catalytic oxidizer. The vapor extraction tank will provide a pneumatic vacuum reservoir for the vapor and function as a knockout/receiver tank for removal of water droplets, condensate and particulates that may be entrained in the incoming vapor. Liquid-level sensors in the vapor extraction tank will control automatically the discharge of any accumulated water in the tank. Dual progressive-cavity (positive-displacement) pumps will be used to extract groundwater from the extraction wells. The groundwater extraction pumps will be controlled by the vacuum pressure sensor on the water extraction tank. Extracted groundwater will be pumped to Equalization Tank No. 2 for treatment by the groundwater pretreatment system.

2.4.2 Vapor Phase Treatment System

A thermal/catalytic oxidizer panel will be installed adjacent to the SVE equipment trailer for the destruction of VOCs in the vapor-phase. All vapors from the SVE system will be conveyed to the oxidizer for treatment prior to discharge to the atmosphere.

The thermal/catalytic oxidizer will be provided with an outside air purge system to prevent it from being operated until it has been suitably purged of VOCs. The thermal/catalytic oxidizer will be supplied with its own control panel, which will be interlocked with the SVE control system. The oxidizer must reach an operating temperature of 140^0 F before the SVE system will be allowed to start-up.

2.5 SUMMARY

A summary of the functional description for the three stabilization systems is provided in this section. The complete functional description for the stabilization action is presented in Volume 3 (Operation and Maintenance Manual).

Groundwater Capture System

Groundwater will be pumped from up to four recovery wells in the Production Area and conveyed to the groundwater pretreatment system. Water levels in selected in-river and Production Area monitoring wells/piezometers will be monitored to determine if the gradient is reversed. A differential static water level of up to two-feet will be maintained between the in-river well and its corresponding Production Area monitoring well/piezometer by automatically adjusting the flowrate from each recovery well.

Groundwater Pretreatment System

Groundwater extracted from the groundwater capture and SVE system will be pretreated on-site prior to discharge. The groundwater pretreatment system will remove metals and VOCs from the groundwater. The groundwater pretreatment system will consist of aqueous-phase treatment; vapor-phase treatment; and sludge handling/dewatering. Equalization will be provided to minimize the fluctuations in groundwater flow and contaminant loading. Dissolved ferrous iron in the groundwater will be oxidized using air. A back-up chemical oxidation system using hydrogen peroxide will also be provided.

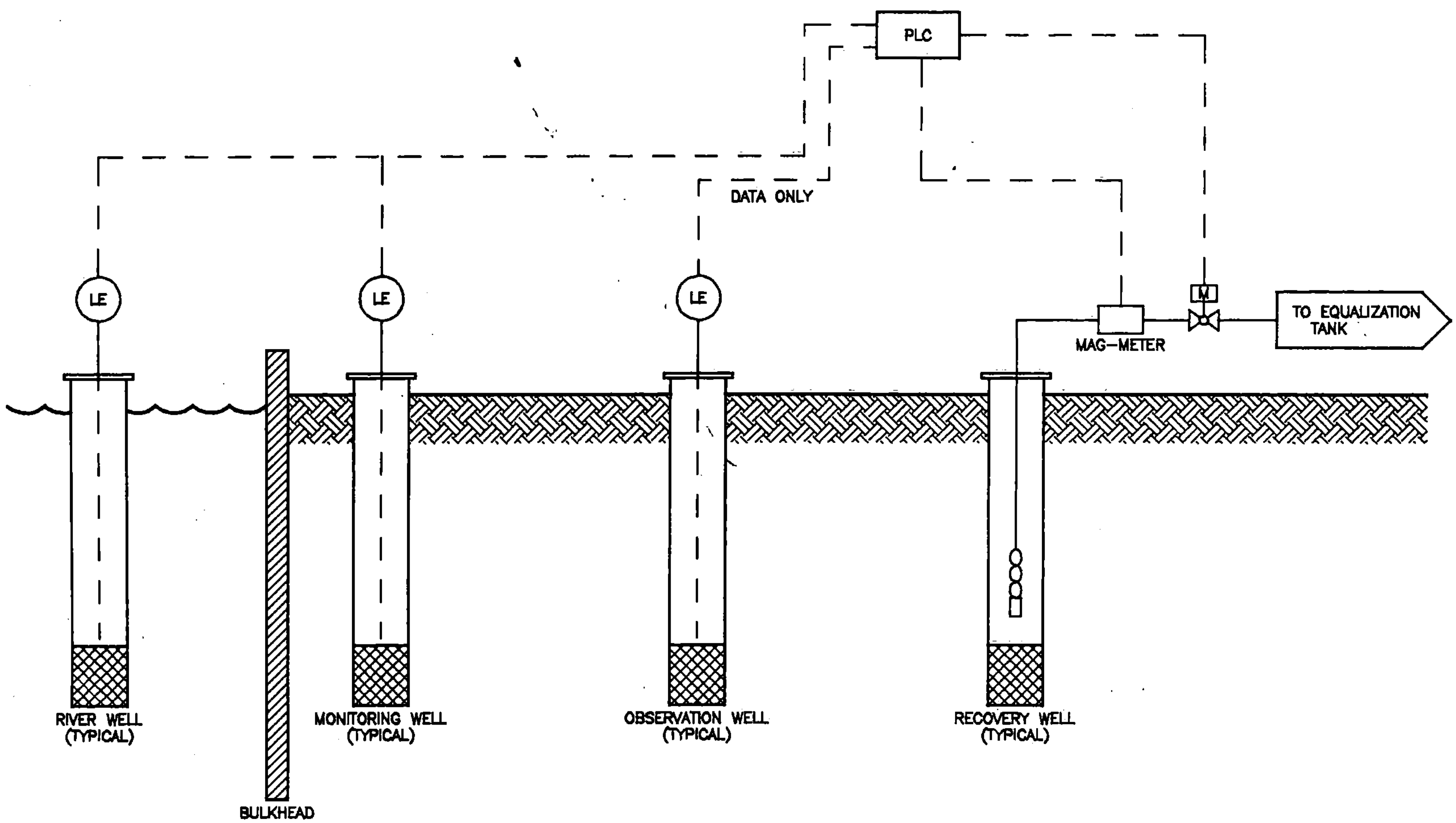
An inclined-plate separator will be provided to remove the metal precipitates formed during air-oxidation. Excess sludge will be transferred to the sludge holding tank. The sand filter will remove any residual suspended solids in the overflow prior to air stripping. A down-flow countercurrent air stripper will be provided to remove VOC's from the groundwater. Aqueous-phase activated carbon will be provided to remove residual organic compounds prior to discharge. A final pH control system will be provided to adjust the pH of the treated groundwater to within the permitted range of values before being discharged to the City of Cranston sanitary sewer.

Saturated air containing VOCs from air stripping will be treated using vapor-phase activated carbon. The treated air will be discharged to the atmosphere. Sludge generated during groundwater pretreatment will be dewatered using a recessed plate filter press.

Soil Vapor Extraction (SVE) System

The SVE system will consist of a soil vapor and groundwater extraction system and a thermal/catalytic oxidizer. The SVE system will include four dual-phase extraction wells and three groundwater extraction wells. The four dual-phase recovery wells will be operated independently to extract groundwater and soil vapor from the subsurface. A positive-displacement, lobe-type vacuum blower will be used to extract soil vapor from the extraction wells and transfer it to the thermal oxidizer for treatment prior to discharge to the atmosphere. Dual progressive-cavity (positive-displacement) pumps will be used to extract groundwater from the extraction wells. Extracted groundwater will be pumped to Equalization Tank No. 2 of the groundwater pretreatment system.

The next chapter discusses the operational performance standards for the stabilization action.



PROCESS FLOW DIAGRAM
FOR THE GROUNDWATER CAPTURE SYSTEM

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR.BY	MVB	SCALE	NONE	DWG.NO.	74660014	PROJ.	87X4660D
CK'D.BY	JJC	DATE	JUNE 15, 1994			FIG.NO.	2-1

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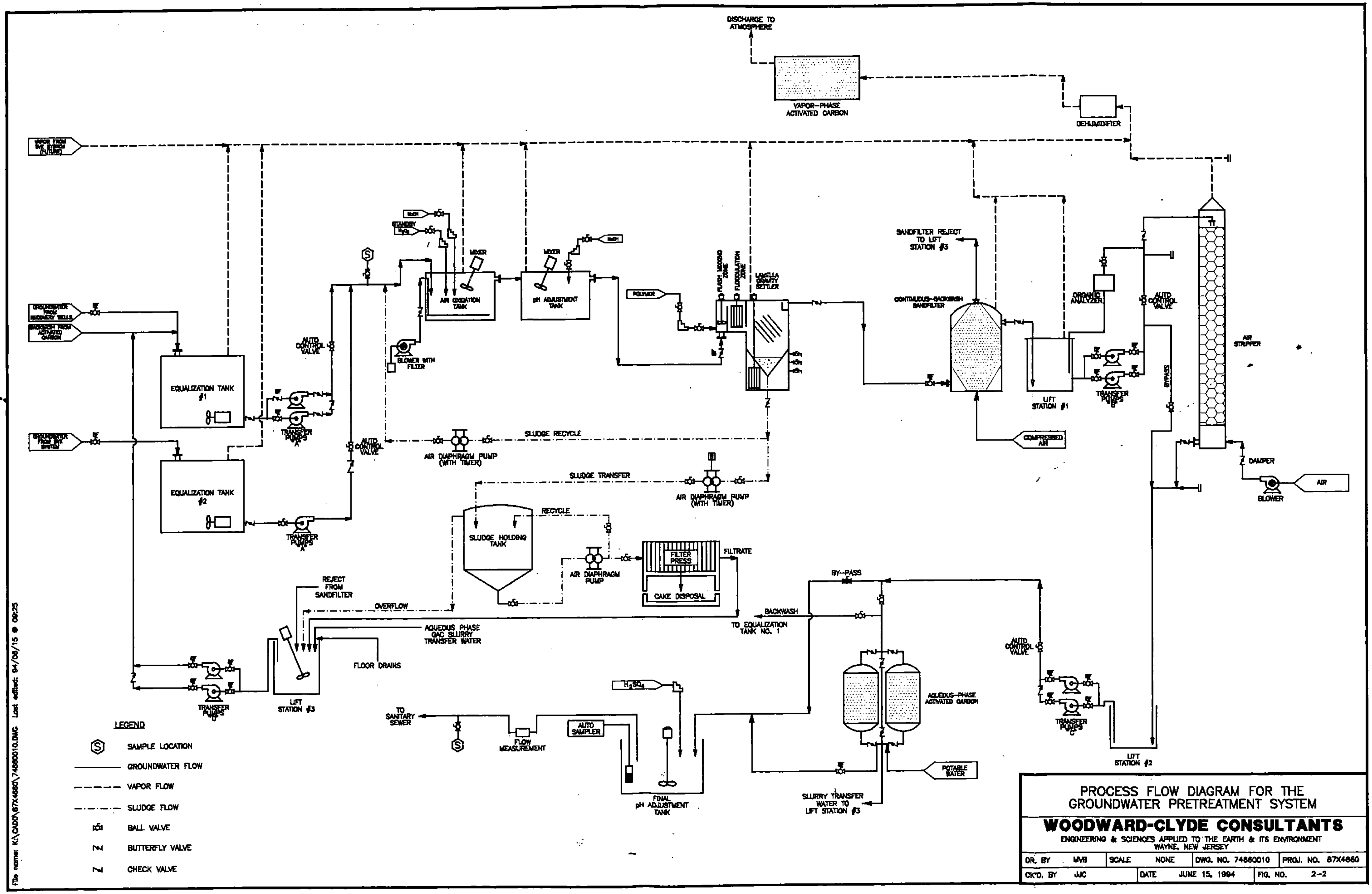
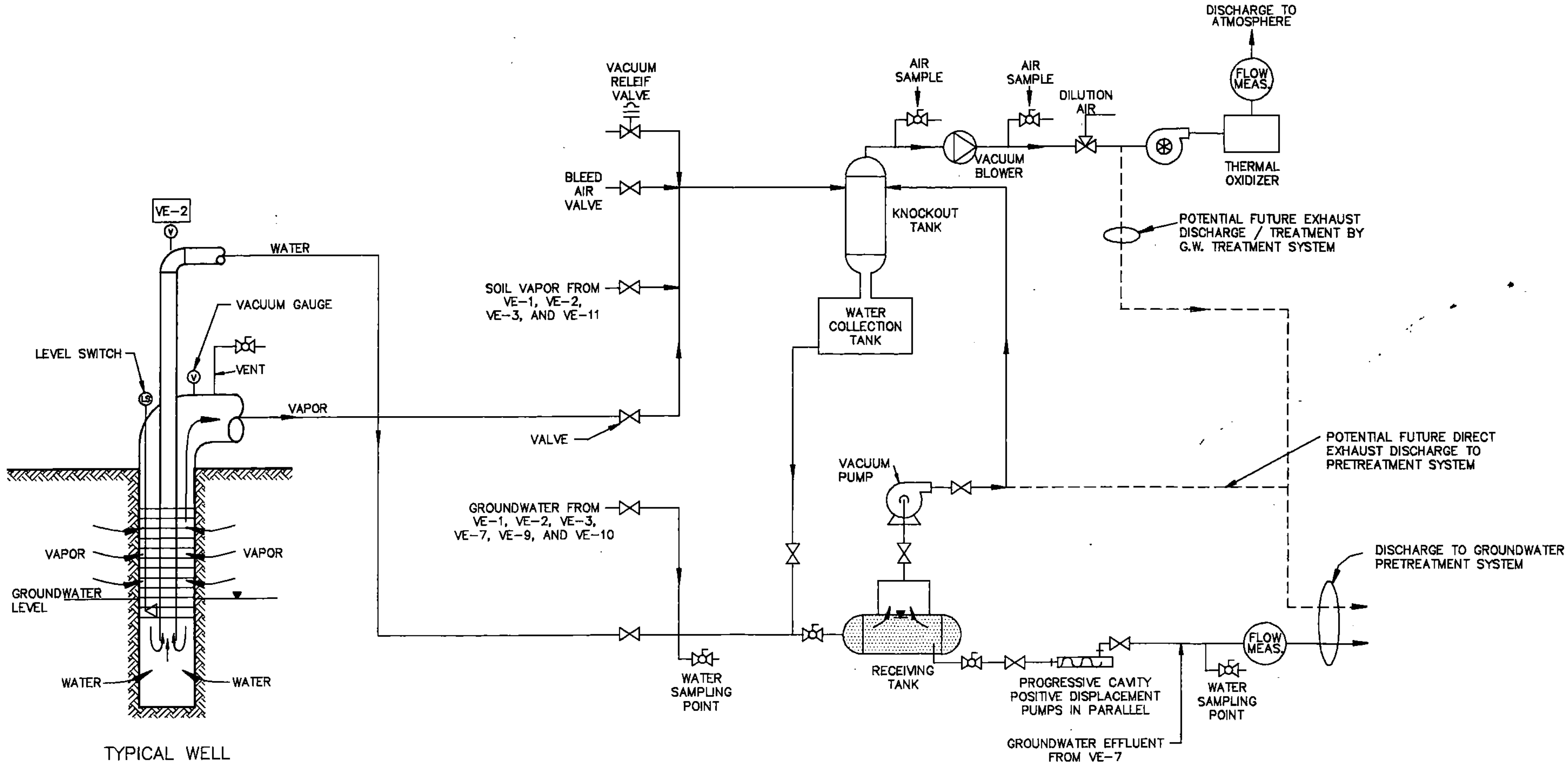


PROCESS FLOW DIAGRAM FOR THE GROUNDWATER PRETREATMENT SYSTEM

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR. BY	MVB	SCALE	NONE	DWG. NO. 74660010	PROJ. NO. 87X4660
CK'D. BY	JJC	DATE	JUNE 15, 1994	FIG. NO.	2-2



TYPICAL WELL CONFIGURATION (DUAL RECOVERY)

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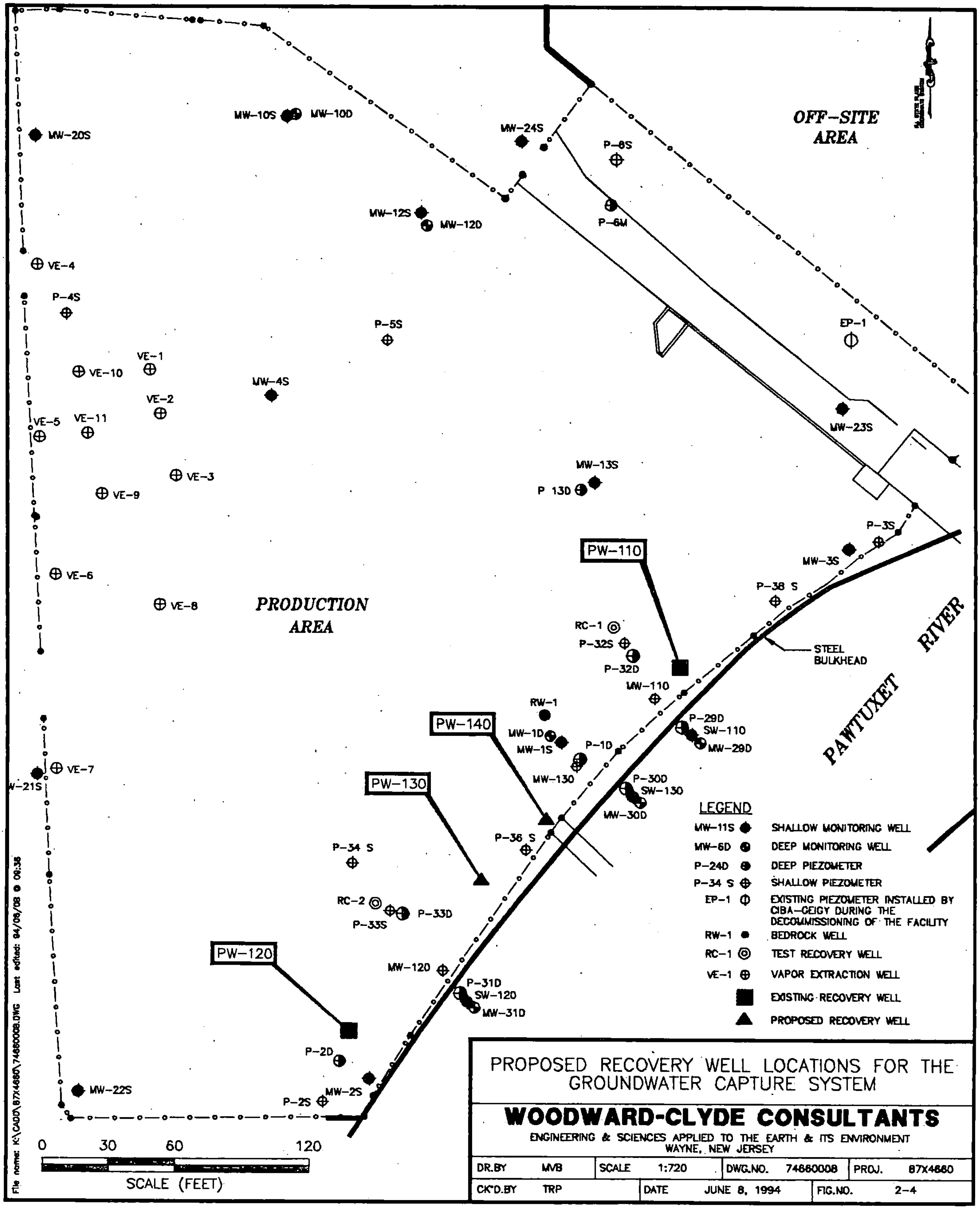
PROCESS FLOW DIAGRAM FOR THE SOIL VAPOR EXTRACTION SYSTEM

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR.BY	BTM	SCALE	AS SHOWN	DWG.NO.	74680006	PROJ.	87X4680
CK'D.BY	TAM	DATE	JUNE 15, 1994	FIG.NO.	2-3		

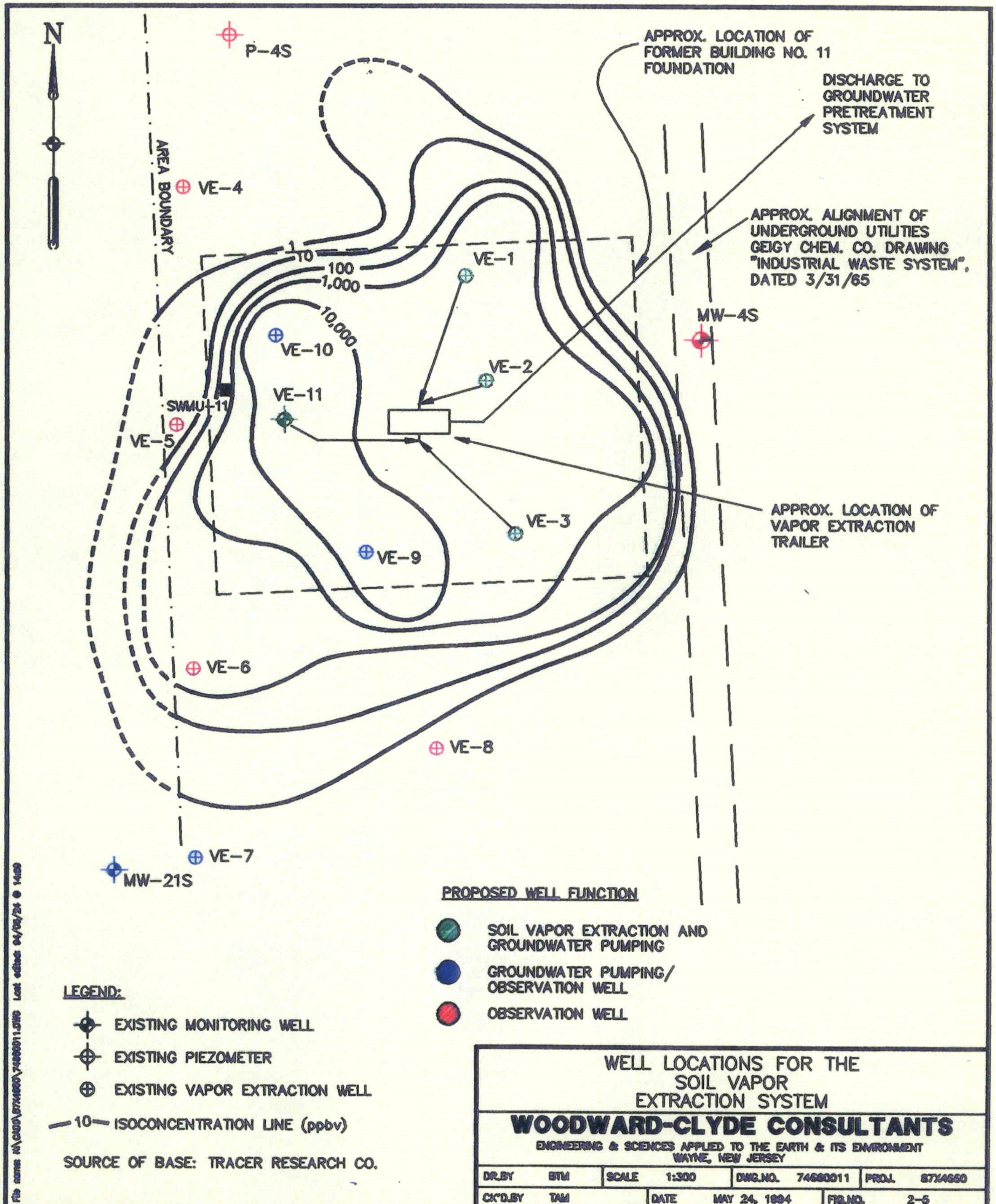


PROPOSED RECOVERY WELL LOCATIONS FOR THE GROUNDWATER CAPTURE SYSTEM

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR.BY	MVB	SCALE	1:720	DWG.NO.	74860008	PROJ.	87X4860
CK'D.BY	TRP	DATE	JUNE 8, 1994	FIG.NO.	2-4		


N
P-4S
APPROX. LOCATION OF FORMER BUILDING NO. 11 FOUNDATION
DISCHARGE TO GROUNDWATER PRETREATMENT SYSTEM
AREA BOUNDARY
VE-4
APPROX. ALIGNMENT OF UNDERGROUND UTILITIES GEIGY CHEM. CO. DRAWING "INDUSTRIAL WASTE SYSTEM", DATED 3/31/65
1
10
100
1,000
10,000
VE-1
MW-4S
VE-10
VE-2
VE-11
SWMU-11
VE-5
VE-3
APPROX. LOCATION OF VAPOR EXTRACTION TRAILER
VE-9
VE-6
VE-8
VE-7
MW-21S
PROPOSED WELL FUNCTION
SOIL VAPOR EXTRACTION AND GROUNDWATER PUMPING
GROUNDWATER PUMPING/ OBSERVATION WELL
OBSERVATION WELL
LEGEND:
EXISTING MONITORING WELL
EXISTING PIEZOMETER
EXISTING VAPOR EXTRACTION WELL
10 ISOCONCENTRATION LINE (ppbv)
SOURCE OF BASE: TRACER RESEARCH CO.
WELL LOCATIONS FOR THE SOIL VAPOR EXTRACTION SYSTEM
WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY
DR.BY BTM
SCALE 1:300
DWG.NO. 74680011
PROJ. 87X4660
CK'D.BY TAM
DATE MAY 24, 1994
FIG.NO. 2-5

Section 3

3.0 OPERATIONAL PERFORMANCE STANDARDS AND PERFORMANCE MONITORING

3.1 OVERVIEW

This chapter presents the operational performance standards for the three stabilization systems. Operational performance standards are defined as those standards that will be met (during the operation of each stabilization system) to ensure that the desired stabilization goals are achieved.

The goal of the groundwater capture system is to minimize the migration of contaminated groundwater from the Production Area to the Pawtuxet River. The operational performance standard for the groundwater capture system is to achieve sufficient drawdown in the Production Area to reverse the hydraulic gradient.

The goal of the groundwater pretreatment system is to remove constituents in the groundwater prior to discharge to the POTW. The operational performance standards of the pretreatment system are to insure that the City of Cranston discharge limitations are met.

The goal of the SVE system is to reduce the mass of VOC from the soil at SWMU-11. The goal of the groundwater capture system at SWMU-11 is to 1) remove contaminated groundwater, and 2) lower the water table to enhance remediation by the SVE system. The operational performance standards of the SVE system are to remove VOC mass from the soil and groundwater at SWMU-11.

Operational performance standards for the three stabilization systems are discussed in three sections:

- Section 3.2 presents the operational performance standards and performance monitoring for the groundwater capture system;

- Section 3.3 presents the operational performance standards and performance monitoring for the pretreatment system (aqueous and vapor phase); and

- Section 3.4 presents the operational performance standards and performance monitoring for the soil vapor extraction system.

3.2 GROUNDWATER CAPTURE SYSTEM

The goal of the groundwater capture system is to prevent or minimize discharges from the Production Area to the Pawtuxet River by reversing the hydraulic gradient at the bulkhead. The operational performance standards to achieve this goal is presented here.

3.2.1 Operational Performance Standards

The groundwater capture system will include up to four pumping wells to reverse the hydraulic gradient at the bulkhead from its present direction towards the Pawtuxet River. Gradient reversal is achieved when water levels are lower on the landward side of the bulkhead than on the Pawtuxet River side of the bulkhead. Two wells (PW-110 and PW-120) have been installed at the locations shown in Figure 2-4. Two additional wells (PW-130 and PW-140) may be installed (at the approximate locations show in Figure 2-4), if additional drawdown is needed to reverse the hydraulic gradient in these areas. Details of the well design for the groundwater capture system are presented in Appendix A.

The performance of the groundwater capture system is based on its ability to reverse the hydraulic gradient at the bulkhead. The hydraulic gradient across the bulkhead (and its variation over time) was evaluated to establish the initial performance standards. These standards will be evaluated continuously during the operation of the groundwater capture system.

The performance standards for the groundwater capture system are based on water level elevations measured during November 1992 through August 1993; (November 30, 1992 was the date that the first round of water levels were measured after piezometers P-35S, P-36S, P-37S and P-38S were installed in the Production Area). Each well/piezometer couplet discussed in this chapter is shown on Figure 2-4 and on Drawing G-2 of Volume 4.

Differences in water level elevations and the hydraulic gradients were measured using the following well/piezometer couplets:

Production Area Monitoring Point	In-River Monitoring Point
MW-110 (formerly P-37S)	SW-110 (formerly MW-29S)
MW-120 (formerly P-35S)	SW-120 (formerly MW-31S)
MW-130 (formerly P-1S)	SW-130 (formerly MW-30S)
P-2D	MW-31D
P-1D	MW-30D

(Note: The following changes in well designations have been made on the drawings and specifications for ease of reference: RC-3, P-37S, and MW-29S are now designated as PW-110, MW-110, and SW-110, respectively. RC-5, P-35S, and MW-31S are now designated as PW-120, MW-120, and SW-120, and RC-4, P-1S, and MW-30S are now designated as PW-130, MW-130, and SW-130).

The differences in water level elevations and the hydraulic gradient between the Production Area monitoring points and the in-river wells is presented in Table 3-1. The hydraulic gradient was calculated by subtracting the water level elevation of the river-well from the water level elevation in the corresponding Production Area monitoring point and then dividing that number by the distance between those two points. A negative hydraulic gradient indicates a potential for groundwater flow towards the river.

As shown in Table 3-1, most of the hydraulic gradients from the nine measurement periods were determined to be negative, indicating that the groundwater flow is mostly towards the river. The average difference in water level elevations varied from -0.27 to -1.39 feet. The corresponding average hydraulic gradient varied from -0.02 to -0.06 feet/foot. The smallest difference in water level elevations and hydraulic gradient were noted between MW-120 and SW-120 near the southern end of the bulkhead. The largest difference was observed between MW-110 and SW-110 near the northern end of the bulkhead in the Production Area.

Based on the nine rounds of water level measurements and the hydraulic gradient calculations presented in Table 3-1, the following minimum drawdown goals are proposed as the initial operating performance standards for the groundwater capture system:

- 0.5 feet of drawdown in the southern portion of the bulkhead as measured by the difference in water level elevations between MW-120 and SW-120;

- 1.0 feet of drawdown in the center portion of the bulkhead as measured by the difference in water level elevations between MW-130 and SW-130; and,

- 1.7 feet of drawdown in the northern portion of the bulkhead as measured by the difference in water level elevations between MW-110 and SW-110.

A graphic presentation of the proposed initial minimum drawdown goals for this groundwater capture system is presented in Figure 3-1.

The proposed drawdown goals are based on the average water level differences across the bulkhead. To provide a safety factor, about 20 percent additional drawdown was added to the calculated drawdowns. This safety factor was added to ensure that gradient reversal will be maintained. (It is customary to add a safety factor in designing groundwater recovery systems due to fluctuations in water levels). Water level elevations/drawdown will be measured both in the well couplets on each side of the bulkhead and in other monitoring points throughout the capture zone to determine the minimum drawdown needs. Details on the operational performance monitoring program are provided in Section 3.2.2.

The reversed hydraulic gradient, (based on the difference in groundwater elevations on both sides of the bulkhead), will vary with seasonal groundwater fluctuations and precipitation. Seasonal water level fluctuations occur slowly and can be compensated for in the controlled drawdown of the recovery wells that are required to maintain the reversed hydraulic gradient.

Changes in water level elevations from precipitation usually occur within 24 hours of a rainfall event. The water level data presented in the Stabilization Investigation Report and Design Concepts Proposal (May, 1993) show the impact of rainfall on water levels. In general, precipitation events greater than 1.0 inch in 24 hours resulted in water level elevation rises in each of the wells monitored continuously in the Production Area. Consistent increases in water levels were recorded in the wells and piezometers on both sides of the bulkhead after a rainfall event were noted. The relative difference in groundwater elevations on both sides of the bulkhead remained similar after a rainfall event, indicating that the gradient was unchanged. Once the reversed hydraulic gradient was established during testing, it was not changed by a rainfall event. As a result, additional pumping during/after a rainfall event to compensate for the increased water level elevations is not required. However, capping of the Production Area could reduce the volume of water required to be captured and may reduce the transport of contaminants from the soil into the groundwater.

3.2.2 Operational Performance Monitoring

Performance monitoring for the groundwater capture system will consist of monitoring water levels to evaluate groundwater gradient reversal and chemical monitoring to evaluate reductions in constituent concentrations in the pumped groundwater.

3.2.2.1 Water Level Monitoring

The water level monitoring program includes: monitoring the difference in water levels across the bulkhead, monitoring of additional wells throughout the capture zones, and background monitoring. Specifically, the program will consist of the following:

- Monitoring the difference in water level elevations between the wells/piezometers on both sides of the bulkhead will be performed to determine whether the required gradient reversal has been achieved. Monitoring will be conducted at couplets MW-110/SW-110, MW-120/SW-120, and MW-130/SW-130 using the data logging function of the PLC. The differences measured will be used to change the pumping rates automatically to control drawdown (criteria presented later in this section). In addition, other well/piezometer couplets (P-1D/MW-30D and P-2D/MW-31D) will be monitored using capacitor probes connected to the PLC. Data from these monitoring points will be evaluated to determine the change in water levels across the bulkhead in the deeper Fine Sand unit due to pumping.

- Monitoring of wells/piezometers near the bulkhead will be performed to determine if the minimum drawdown goals are being met throughout the capture zones. This monitoring will be conducted at locations MW-2S, P-2S, P-36S, P-38S, and MW-3S using capacitor probes. Data from these monitoring points will be recorded by the PLC. These data will be evaluated twice weekly until equilibrium is met and then twice monthly after equilibrium is achieved.

- Monitoring of water levels in wells MW-10S and MW-10D will be performed to determine background groundwater conditions. These data will be collected continuously using the PLC and evaluated monthly. Changes in background water levels will be compared with changes that occur due to the pumping of the recovery wells.

The difference in water levels across the bulkhead will be monitored automatically (and on a continuous basis) by the PLC using the water level data measured from the three well couplets MW-110/SW-110, MW-120/SW-120, and MW-130/SW-130. Water level differences will be controlled by adjusting the pumping rates of the recovery wells. When more drawdown is required to maintain the reversed hydraulic gradient (due to either seasonal or other changes in water level), the pumping rates will be increased. Pumping rates will be adjusted by increasing the opening on the control valve from the pump discharge line. Adjustments of the automatic control valve will be performed automatically when the difference in the water levels between the Production Area piezometer (i.e. MW-110, MW-120, MW-130) and the corresponding in-river well (i.e. SW-110, SW-120, SW-130) indicates that a hydraulic gradient toward the river is occurring. Adjustments will be programmed to occur when the water level elevations in the Production Area wells are 0.1 feet or greater than the corresponding elevations in the river-wells for a period of at least 48 hours. Using this criteria minimizes the number of adjustments required without compromising the goals of the groundwater capture system.

3.2.2.2 Chemical Monitoring

Operational performance monitoring will also include the analysis of groundwater samples. Groundwater samples will be analyzed to evaluate changes in groundwater chemistry that occur due to pumping. The following sampling program is proposed and is summarized on Table 3-2:

- Two rounds of groundwater sampling will be performed during the first year of operation in selected Production Area monitoring wells after the groundwater capture system is operational. This sampling, while part of the Phase II investigation work, will be used to evaluate constituent changes during the first year of operation. Each sample will be analyzed for Appendix IX compounds, fingerprint compounds, and major and minor ions.

- Recovery wells will be sampled quarterly to evaluate changes in groundwater chemistry and influent constituent concentrations to the pretreatment system. These samples will be analyzed for Target Compound List Volatile Organic Compounds (TCL VOCs), total iron and manganese.

- Monitoring wells MW-1S, MW-2S, MW-110, MW-120, P-36S, and P-38S will be sampled quarterly during year two and semi-annually (after year two) to evaluate chemical changes in the shallow groundwater in the Production Area. The samples will be analyzed for TCL VOCs. The frequency of groundwater sampling is being reduced after year two because the data from the eight rounds of groundwater samples collected before year 2 will be more than enough to evaluate the trends in contaminant concentrations that are occurring in groundwater due to pumping. Decreasing the sampling frequency after year two to semi-annually will not affect the evaluation of chemical data trends.

3.3 GROUNDWATER PRETREATMENT SYSTEM

The objective of the groundwater pretreatment system is to remove inorganic and organic constituents from the extracted groundwater prior to discharge to the POTW. The operational performance standard of the pretreatment system is to insure that the discharge limitations are met.

The design of the groundwater pretreatment system was based on data obtained during the bence-scale testing program and the on-site pilot pretreatment program discussed in the Stabilization Investigation Report and Design Concepts Proposal (May, 1993). As designed, the groundwater pretreatment system contains two components; aqueous-phase treatment and vapor-phase treatment.

3.3.1 Aqueous-Phase Treatment - Operational Performance Standards

Groundwater from both the groundwater capture system and the SVE system will be conveyed to the pretreatment system via an above-grade forcemain. Following equalization, metals oxidation, flocculation/clarification, sand filtration, air stripping and activated carbon adsorption, the groundwater will be discharged to the City of Cranston POTW via an existing sanitary sewer connection. For the aqueous-phase treatment portion of the groundwater pretreatment system, the required performance standards are the City of Cranston effluent quality standards. The City of Cranston performance standards for the aqueous-phase treatment portion of the groundwater pretreatment system are presented in Table 3-3.

3.3.2 Aqueous-Phase Treatment - Operational Performance Monitoring

Effluent from the groundwater pretreatment system will be conveyed to the City of Cranston sanitary sewer and eventually the POTW. Prior to entering the sanitary sewer, the effluent will be sampled using an ISCO sampler. In accordance with the City of Cranston's Self-Monitoring Report requirements, 24-hour effluent composite samples will be collected twice per month (on the first and third week) for the first six months of system operation. Grab samples for VOCs will also be collected on the first and third week of every month. Analysis of the effluent will be performed to ensure that the operational performance standards noted in Section 3.3.1 are achieved. After about six months of operation, the City of Cranston may reduce the required sampling period from twice per month to bi-monthly (once every two months). Eventually, the required performance sampling/reporting effort may be reduced to quarterly by the City of Cranston.

3.3.3 Vapor-Phase Treatment - Operational Performance Standards

The groundwater pretreatment system design includes air stripping followed by vapor-phase activated carbon adsorption. Following treatment, the discharge from the vapor-phase activated carbon will be exhausted to the atmosphere. The operational performance standards proposed for the vapor-phase portion of the groundwater pretreatment system are the standards developed and established by the Rhode Island Department of Environmental Management (RIDEM) -Division of Air and Hazardous Materials. These maximum allowable emission rates have been established by RIDEM to ensure the overall protection of the environment and to minimize any potential impacts to human health. The RIDEM performance standards for the vapor-phase treatment portion of the groundwater pretreatment system are presented in Table 3-4.

3.3.4 Vapor-Phase Treatment - Operational Performance Monitoring

The discharge from the vapor-phase activated carbon adsorption system will be exhausted to the atmosphere after treatment. In accordance with the reporting requirements of RIDEM - Division of Air and Hazardous Materials, sampling of the vapor-phase activated carbon exhaust will be performed at the beginning of system operation to demonstrate compliance with the performance standards noted in Section 3.3.3. Following start-up, sampling and reporting to RIDEM will be performed annually.

3.4 SOIL VAPOR EXTRACTION SYSTEM

The goal of the SVE system in SWMU-11 is to reduce the mass of VOCs from the soil and groundwater. The groundwater portion of the SWMU-11 system is designed to remove contaminated groundwater (where SVE is taking place) and lower the water table so that additional soil can be remediated. The operational performance standards of the SVE system are presented here.

3.4.1 Operational Performance Standards

The design of the stabilization system for SWMU-11 includes both soil vapor and groundwater extraction to remove constituents from the saturated and unsaturated zones. The operational performance of the SVE and groundwater extraction systems in SWMU-11 are based on their ability to reduce contaminant mass in the soil and groundwater.

The operational performance of the SVE system will be determined by the concentrations of constituents being removed from the soil. In order to remove constituents from the soil gas, a vacuum must be applied with an air flow measured throughout the SWMU-11 area.

Soil vapor will be extracted from VE-1, VE-2, VE-3, and VE-11. Extraction wells VE-7, VE-9, and VE-10, initially will be used for groundwater capture only. Vacuum and airflow will be monitored in each of these seven wells and in the observation wells (VE-4, VE-5, VE-6, VE-8, P-4S, and MW-4S). Based on the results of the HIVAC pilot test (presented in the Stabilization Investigation Report and Design Concepts Proposal (May 1993)), the amount of vacuum that will be maintained throughout the footprint of former Building No. 11 will range from about 1.0 to 5.2 millimeters of Hg; airflow rates are expected to range from about 0.8 to 2.0 liters per minute. The final vacuum/airflow operational performance standards will be selected after startup.

Soil vapors extracted at SWMU-11 will be treated by a thermal/catalytic oxidizer prior to discharge to the atmosphere. The operational performance standards proposed for the treatment of soil vapors from the SVE system will be the standards developed and established by RIDEM's - Division of Air and Hazardous Materials (Table 3-4). The RIDEM performance standards for the soil vapor are identical to those performance standards presented for the vapor-phase portion of the groundwater pretreatment system (presented in Section 3.3.3).

The performance of the groundwater extraction system for SWMU-11 will be based on the mass of constituents removed from the area and from the benefit achieved by lowering the water table to expose more soil for constituent removal by SVE. There are no hydraulic performance criteria proposed for the SWMU-11 groundwater extraction system. However, drawdown will be measured periodically in the seven extraction and six observation wells (Figure 2-5) to evaluate the influence of groundwater extraction on the SVE system.

The groundwater extracted by the SWMU-11 wells will be conveyed to the groundwater pretreatment system for treatment prior to discharge to the sanitary sewer and POTW. Performance standards for the aqueous-phase portion of the groundwater treatment system are presented in Table 3-3.

3.4.2 Operational Performance Monitoring

Operational performance monitoring for the SVE system will be performed to ensure that air emissions are in compliance with RIDEM's standards and the groundwater discharges are in compliance with the POTW limits (as stated in Sections 3.3.2 and 3.3.4). Operational performance monitoring of the air emissions and groundwater discharges will be included as part of the groundwater pretreatment system operation performance monitoring which is presented in Sections 3.3.2 and 3.3.4.

Operational monitoring will consist of monthly sampling of soil vapor (one sample per month) from the vacuum blower effluent. These samples will be analyzed for VOCs.

Groundwater from each of the seven SVE system wells will be sampled quarterly; samples will be analyzed for VOCs.

3.5 SUMMARY

This chapter described the operational performance standards and the operational performance monitoring for the groundwater capture, groundwater pretreatment, and SVE systems.

Groundwater Capture System

The groundwater capture system will include up to four pumping wells to reverse the hydraulic gradient at the bulkhead. Representative hydraulic gradients were determined from well/piezometer couplets that are located on both sides of the bulkhead. The minimum drawdown goals for the groundwater capture system are 0.5 feet of drawdown in the southern portion of the bulkhead; 1.0 feet of drawdown in the center portion of the bulkhead; and 1.7 feet of drawdown in the northern portion of the bulkhead. The proposed drawdown goals are based on the average water level difference across the bulkhead and include a 20 percent safety factor.

Operational performance monitoring for the groundwater recovery system will consist of monitoring water levels and the analyzing groundwater samples. Monitoring will be performed to determine the difference in water level elevations between monitoring points on both sides of the bulkhead to determine whether the gradient is reversed, if the recovery wells produce the drawdown required to reverse the gradient throughout their capture zones, and to observe background water levels.

Groundwater samples will be analyzed to evaluate changes in groundwater chemistry that occur due to pumping. Two rounds of groundwater sampling will be conducted as part of the Phase II RCRA Facility Investigation. In addition, groundwater from the recovery wells will be sampled quarterly and selected monitoring wells will be sampled semi-annually (see Table 3-1). These samples will be analyzed for VOCs.

Groundwater Pretreatment System

The groundwater pretreatment system is designed to remove metals and VOCs from the groundwater extracted from the Production Area. The groundwater pretreatment system includes two components; aqueous-phase treatment and vapor-phase treatment. Groundwater from both the groundwater capture system and the SVE system will be conveyed to the pretreatment system. Following pretreatment, the groundwater will be discharged to the City of Cranston POTW. For the aqueous-phase treatment portion of the groundwater pretreatment system, the City of Cranston POTW discharge standards will be met. Air discharge from the vapor-phase activated carbon system will be exhausted to the atmosphere. The performance standards proposed for the vapor-phase portion of the groundwater pretreatment system are the maximum allowable emission standards developed and established by RIDEM - Division of Air and Hazardous Materials.

In accordance with the City of Cranston's Self-Monitoring Report requirements, 24-hour effluent composite samples will be collected twice per month for the first six months of system operation. Grab samples for VOCs will the be collected on the first and third week of every month. After about six months of operation, the City of Cranston may reduce the required sampling period from twice per month to bi-monthly. In accordance with the reporting requirements of RIDEM - Division of Air and Hazardous Materials, performance sampling of the vapor-phase activated carbon exhaust will be performed at the beginning of system operation and then annually.

Soil Vapor Extraction (SVE) System

The design of the stabilization system for SWMU-11 includes both soil vapor and groundwater extraction to remove constituents from the saturated and unsaturated zones. The operational performance of the SVE system will be based on its ability to reduce constituent concentrations. This performance will be measured by the vacuum and airflow in the proposed observation wells. The performance of the SWMU-11 groundwater extraction system will be based on the mass of constituents removed. Soil vapors extracted during stabilization activities in SWMU-11 will be treated using a thermal/catalytic oxidizer prior to discharge to the atmosphere. The performance standards proposed for the soil vapor portion of the SVE system will be the maximum allowable emission standards developed by RIDEM's - Division of Air and Hazardous Materials. Groundwater extracted by the SVE system will be conveyed to the on-site groundwater pretreatment system for treatment prior to discharge to the sanitary sewer and POTW.

The next chapter discusses the shut-down criteria and confirmatory sampling plans for the stabilization systems.

TABLE 3-1
DIFFERENCES IN WATER LEVEL ELEVATIONS AND HYDRAULIC GRADIENTS ACROSS THE BULKHEAD

Monitoring Point	Reference Elevation (ft MSL)	DEPTH TO WATER MEASUREMENTS (feet below reference elevation) 11/30/92	2/3/93	2/25/93	3/31/93	4/29/93	5/27/93	6/30/93	7/29/93	8/30/93
P-35S	15.32	5.97	5.93	5.51	3.46	5.02	6.86	7.24	6.99	7.35
P-2D	16.00	6.77	6.59	6.14	3.80	5.65	7.24	7.66	7.49	7.10
MW-31S	16.27	6.97	6.79	6.46	4.34	6.42	8.04	9.70	8.18	8.45
MW-31D	16.21	6.97	6.96	6.52	4.30	6.43	8.24	8.38	7.99	8.30
P-1S	16.41	6.55	7.25	6.78	4.70	7.95	7.50	7.96	7.41	8.18
P-1D	16.33	7.20	8.15	7.81	7.30	6.92	7.20	7.64	7.91	8.00
MW-30S	16.70	8.31	8.37	7.87	5.20	7.73	9.40	8.40	9.40	9.68
MW-30D	16.67	8.27	8.20	7.93	5.22	7.76	9.50	9.70	9.42	9.66
P-37S	15.69	5.73	6.23	5.81	3.41	5.21	6.50	6.90	6.70	7.00
MW-29S	16.66	8.15	8.21	7.97	5.21	7.80	8.50	9.78	9.36	9.71

Monitoring Point	Reference Elevation (ft MSL)	WATER LEVEL ELEVATIONS (feet Mean Sea Level) 11/30/92	2/3/93	2/25/93	3/31/93	4/29/93	5/27/93	6/30/93	7/29/93	8/30/93
P-35S	15.32	9.35	9.39	9.81	11.86	10.30	8.46	8.08	8.33	7.97
P-2D	16.00	9.23	9.41	9.86	12.20	10.35	8.76	8.34	8.51	8.90
MW-31S	16.27	9.30	9.48	9.81	11.93	9.85	8.23	6.57	8.09	7.82
MW-31D	16.21	9.24	9.25	9.69	11.91	9.78	7.97	7.83	8.22	7.91
P-1S	16.41	9.86	9.16	9.63	11.71	8.46	8.91	8.45	9.00	8.23
P-1D	16.33	9.13	8.18	8.52	9.03	9.41	9.13	8.69	8.42	8.33
MW-30S	16.70	8.39	8.33	8.83	11.50	8.97	7.30	8.30	7.30	7.02
MW-30D	16.67	8.40	8.47	8.74	11.45	8.91	7.17	6.97	7.25	7.01
P-37S	15.69	9.96	9.46	9.88	12.28	10.48	9.19	8.79	8.99	8.69
MW-29S	16.66	8.51	8.45	8.69	11.45	8.86	8.16	6.88	7.30	6.95

Monitoring Point	Distance Between Points (ft)	DIFFERENCE IN WATER LEVEL ELEVATIONS ACROSS THE BULKHEAD (feet) 11/30/93	2/3/93	2/25/93	3/31/93	4/29/93	5/27/93	6/30/93	7/29/93	8/30/93	Average Difference (ft)	Average Gradient (feet/foot)
P-35S/MW-31S	17	-0.05	0.09	0.00	0.07	-0.45	-0.23	-1.51	-0.24	-0.15	-0.27	-0.02
P-2D/MW-31D	65	0.01	-0.16	-0.17	-0.29	-0.57	-0.79	-0.51	-0.29	-0.99	-0.42	-0.01
P-1S/MW-30S	30	-1.47	-0.83	-0.80	-0.21	0.51	-1.61	-0.15	-1.70	-1.21	-0.83	-0.03
P-1D/MW-30D	33	-0.73	0.29	0.22	2.42	-0.50	-1.96	-1.72	-1.17	-1.32	-0.50	-0.02
P-37S/MW-29S	23	-1.45	-1.01	-1.19	-0.83	-1.62	-1.03	-1.91	-1.69	-1.74	-1.39	-0.06
		negative numbers indicate flow potential into river										

TABLE 3-2
GROUNDWATER CAPTURE SYSTEM
OPERATIONAL PERFORMANCE
CHEMICAL MONITORING PROGRAM

Wells to Be Sampled	Year 1 After Startup	Year 2 After Startup	After Year 2
Selected Production Area Monitoring Wells	Sampled semi-annually (as part of Phase II) for Appendix IX, fingerprint compounds, major and minor ions	No sampling proposed (Phase II RFI completed)	No sampling proposed (Phase II RFI completed)
Recovery Wells PW-110, PW-120, PW-130*, PW-140*	Sampled quarterly for TCL VOCs and total iron and manganese	Sampled quarterly for TCL VOCs and total iron and manganese	Sampled quarterly for TCL VOCs and total iron and manganese
Monitoring Wells MW-1S, MW-2S, MW-110, MW-120, P-36S, P-38S	Sampled semi-annually (as part of Phase II) for Appendix IX, fingerprint compounds, major and minor ions	Sampled quarterly for TCL VOCs	Sampled semi-annually for TCL VOCs

* Recovery wells PW-130 and PW-140 will be installed only if needed

TCL VOCs - Target Compound List Volatile Organic Compounds

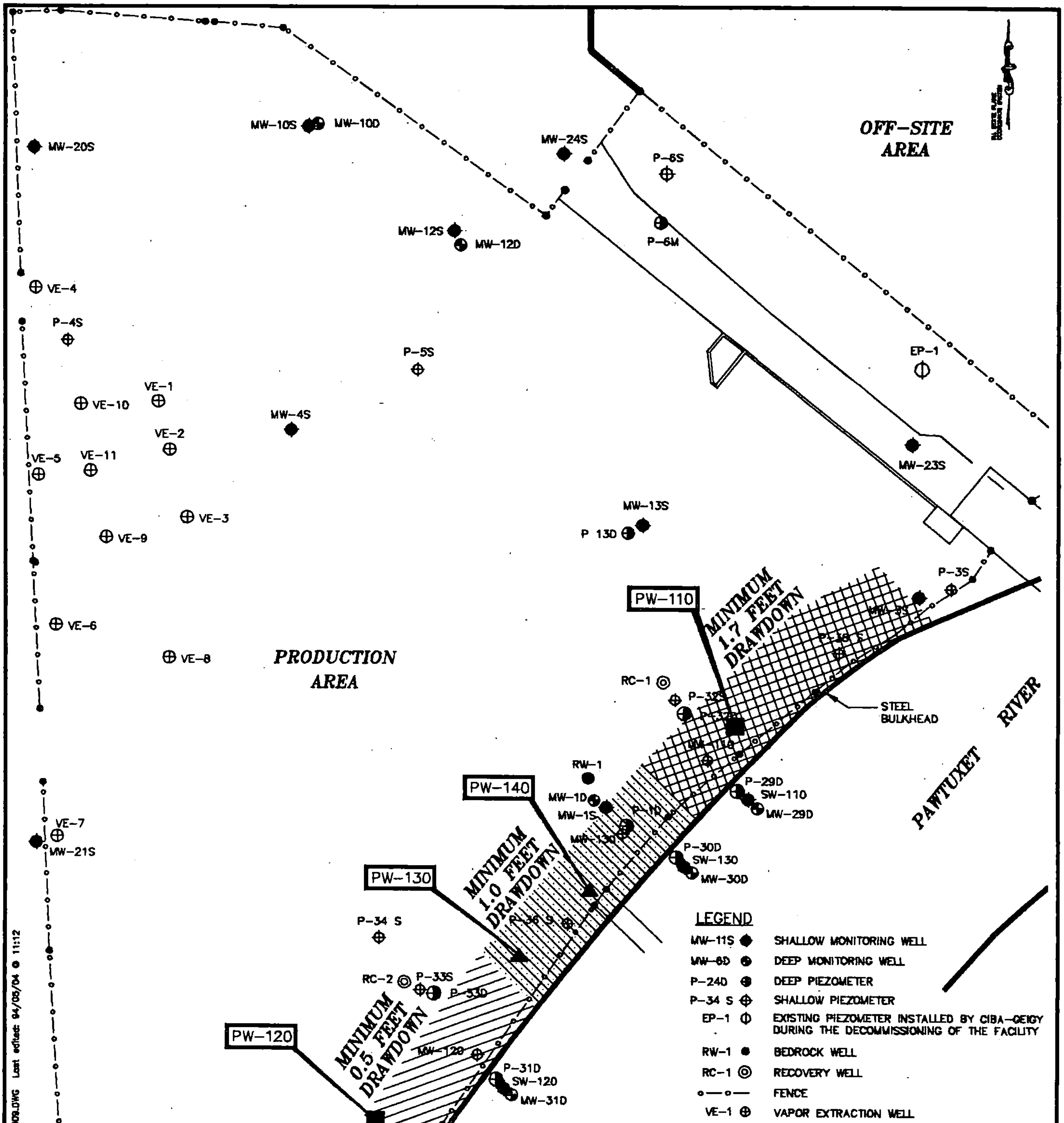
Table 3-3
Proposed Performance Standards
Stabilization Action - Cranston, Rhode Island
Groundwater Pretreatment System
Aqueous-Phase Treatment

Parameter	**Effluent Concentration (mg/l)**
Antimony (total)	0.05
Arsenic (total)	0.1
Beryllium (total)	0.005
Boron (total)	1.0
Cadmium (total)	0.04
Chromium (total)	0.4
Copper (total)	1.0
Cyanide (total)	0.3
Iron (total)	2.0
Lead (total)	0.3
Manganese (total)	2.0
Mercury (total)	0.005
Nickel (total)	0.7
Phenols (total)	1.0
Selenium (total)	0.01
Silver (total)	0.1
Thallium (total)	0.005
Zinc (total)	1.0
Total Toxic Organics	2.13
Oil and Grease	25 Mineral/Petroleum Origin 100 Animal/Vegetable Origin
pH	5.5 to 9.5 units

Table 3-4
Proposed Performance Standards
Stabilization Action - Cranston, Rhode Island
Groundwater Pretreatment System
Vapor-Phase Treatment

Parameter	Maximum Emission Rate (lb/hr)
Acrylonitrile	0.004
Aniline	0.04
O-Anisidine	0.001
Antimony & Antimony Compounds	1.14
Arsenic & Arsenic Compounds	0.0
Benzene	0.005
Benzidine	0.0
Benzotrichloride	0.0
Benzyl Chloride	0.005
Cadmium & Cadmium Compounds	0.0
Carbon Tetrachloride	0.001
Chloroform	0.002
Chromium & Chromium Compounds	0.0
3,3'-dichlorobenzidine	0.0001
Dioctyl Phthalate	0.03
Diphenyl	0.02
Diphenyl Amine	1.14
Epichlorohydrin	0.04
Ethylene Dichloride	0.002
Ethylene Oxide	0.0005
Hydrazine	0.0
Hydrogen Chloride	1.14
Hydrogen Fluoride	0.1

Table 3-4 Proposed Performance Standards Stabilization Action - Cranston, Rhode Island Groundwater Pretreatment System Vapor-Phase Treatment	
Parameter	**Maximum Emission Rate (lb/hr)**
Lead	1.14
Manganese & Manganese Compounds	0.01
Methyl Cellosolve	1.14
Methylene Biphenyl Iscyante (MDI)	0.003
4,4'-Methylene bis(2-chloroaniliine)	0.05
Methylene Chloride	0.01
Nickel & Nickel Compounds	0.0001
5-Nitro (o-anisidine)	0.004
2-Nitropropane	0.01
Perchloroethylene	0.002
Styrene	1.14
Toluene	1.14
Toluene-2,4 Diisocyanate (TDI)	0.001
O-Toluidene	0.002
1,1,2 Trichloroethane	0.3
Trichloroethylene	0.02
Triethylamine	1.14
Xylene	1.14
Other Contaminants	10



MINIMUM DESIGN DRAWDOWN GOALS

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WAYNE, NEW JERSEY

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Section 4

4.0
SHUT-DOWN CRITERIA
CONFIRMATORY SAMPLING PLANS

4.1 OVERVIEW

This chapter presents the shut-down criteria and confirmatory sampling plans for the groundwater capture system, groundwater pretreatment system, and the SVE system. Operational monitoring data will be evaluated as an indicator that the shut-down criteria have been met. Confirmatory sampling will be conducted after the system is shut-down to ensure that constituent concentrations in the targeted environmental media have met the shut-down criteria.

Shut-down criteria and confirmatory sampling plans for the three stabilization systems are discussed in three sections:

- Section 4.2 presents the shut-down criteria and confirmatory sampling plan for the groundwater capture system;
- Section 4.3 presents the shut-down criteria and confirmatory sampling plan for the pretreatment system (aqueous and vapor phase); and
- Section 4.4 presents the shut-down criteria and confirmatory sampling plan for the SVE system.

4.2 GROUNDWATER CAPTURE SYSTEM

The groundwater capture system is designed to reverse the hydraulic gradient at the bulkhead. The shut-down criteria and confirmatory sampling plan for the groundwater capture system are presented here. Confirmatory sampling will be performed after the groundwater capture system is shut-down to ensure that the shut-down criteria have been met.

4.2.1 Shut-Down Criteria

Groundwater capture will take place in the Production Area until the shut-down criteria are met. These shut-down criteria have not been developed because these criteria will be based on media protection standards (MPS). These standards will be developed during Phase II of the RCRA Facility Investigation.

In the interim, the groundwater capture system will be monitored (as described in Section 3.2.2.2). If the concentration of VOCs in the groundwater become statistically flat for four sampling rounds, then the possibility of flushing/surging the aquifer will be considered.

Intermittent shut down of the groundwater capture system may result in an increase in constituent concentrations in groundwater because the constituents that are adsorbed to the soil (above the drawdown water level) may become dissolved in groundwater following recovery. The operational monitoring data will be used to determine if flushing/surging will reduce constituent concentrations in groundwater. By evaluating concentration trends of selected constituents over time, the trend of constituent levels, both during pumping and after pumping is stopped, will be established. These data can be used to establish the optimum pumping schedule for the groundwater capture system (pumping for the minimum amount of time and achieving the maximum benefit).

If flushing/surging is considered to be feasible, it will most likely be performed as part of the final measure for remediating contaminated groundwater in the Production Area. The shut-down criteria for this activity will be determined as part of the design for the final remedy.

4.2.2 Confirmatory Sampling Plan

Confirmatory sampling for the groundwater capture system will be conducted to determine if the shut-down criteria have been met. Groundwater in recovery wells (PW-110, PW-120) and in monitoring wells/piezometers (MW-1S, MW-2S, MW-110, MW-120, P-36S, and P-38S) will be sampled once every 2 months for the first 6 months after the groundwater capture system is shut down. Thereafter, these wells will be sampled semi-annually for an additional year. Groundwater sampled during confirmatory sampling will be analyzed for TCL VOCs only, the primary constituents of concern detected in the Production Area groundwater. (Note, a different confirmatory sampling schedule will be followed if flushing/surging is conducted. This schedule will be developed after operations have commenced.)

Increases in constituent concentrations in groundwater may be observed after the capture system is shut down. If increases in VOC constituent concentrations are detected in a confirmatory sample, that well (or wells) will be re-sampled. If the increased constituent concentrations are confirmed and exceed the specified shut-down criteria, then the benefits of re-starting the groundwater capture system (and pretreatment system) will be evaluated.. Details for re-starting the groundwater capture system will be developed as part of the design of the final remedy for the site.

4.3 GROUNDWATER PRETREATMENT SYSTEM

The objective of the groundwater pretreatment system is to remove inorganic and organic constituents from the extracted groundwater during stabilization. The shut-down criteria for the pretreatment system is presented here.

4.3.1 Shut-Down Criteria

There are no shut-down criteria for the groundwater pretreatment system. The groundwater pretreatment system will be operated as long as groundwater from either the groundwater capture system or the SVE system is being extracted.

As with any treatment system, temporary shut-down periods for equipment replacement, maintenance and emergency repairs are anticipated during operation of the system. Shut-down periods for regular equipment maintenance or instrumentation re-calibration could run from 1 to 2 weeks, possibly longer, depending on the type of maintenance or re-calibration required. Major equipment failure or replacement could require a system shut-down of 6 to 10 weeks, depending on the availability, type and installation procedures for the equipment. Catastrophic system failures could require shut-down periods in excess of 10 weeks. Based on the calculations presented in the Stabilization Investigation Report and Design Concepts Proposal (May 3, 1993), the travel time of groundwater beyond the capture zone was determined to be at least 4 to 6 months. As a result, shut-down periods such as those noted above should not impact meeting the objectives of stabilization.

4.3.2 Confirmatory Sampling Plan

There is no confirmatory sampling required for the groundwater pretreatment system; it will be operated only as long as the groundwater capture system is operated. Any requirements for decommissioning (and decontamination) will be performed in accordance with the regulations appropriate when the system is no longer operational.

4.4 SOIL VAPOR EXTRACTION SYSTEM

The design of the stabilization system for SWMU-11 includes extraction of both soil vapor and groundwater to remove constituents from the saturated and unsaturated zones. The shut-down criteria and confirmatory sampling plan for the SVE system are presented here. Sampling will be performed after the SVE system is shut-down to determine the benefits achieved from operating the SVE system.

4.4.1 Shut-Down Criteria

The shut-down criteria for the SVE system will be based on the operational performance monitoring data presented in Section 3.4.2. The SVE system will be operated until the concentrations of VOCs in the extracted soil vapor remain statistically flat (asymptotic as determined by data regression) for a six month period using monthly soil vapor data. Increases in soil gas VOC concentrations may be observed after the SVE system is shut down. The goal of the SVE system is to remove constituent mass from the unsaturated soil, not to achieve a specific cleanup level. If soil gas concentrations increase after shut-down, the benefits of continuing the operation of this system will be evaluated. Prior to re-starting the SVE system (if appropriate), the results of this evaluation will be discussed with USEPA.

The shut down of the groundwater recovery wells in SWMU-11 will be linked to the operation of the SVE system. When the SVE system is shut down, pumping of groundwater (from wells VE-1, -2, -3, -7, -9, -10, -11) in SWMU-11 will be terminated. This decision is based on the goals of the groundwater extraction system in SWMU-11. Groundwater is being pumped at SWMU-11 to reduce VOC constituent mass and to aid in the efficiency of the SVE system by lowering water levels and exposing more soil for SVE cleanup.

There are no quantitative shut-down criteria for groundwater in SWMU-11. If the concentrations of VOCs in the groundwater at SWMU-11 are significantly higher than the constituent levels measured in the recovery wells along the bulkhead, then re-starting the groundwater extraction pumps at SWMU-11 will be considered. Prior to re-starting these pumps, the results of this evaluation will be discussed with USEPA.

4.4.2 Confirmatory Sampling Plan

Because there are no quantitative shut-down criteria for the SVE system, confirmatory sampling of soil vapor and groundwater (at SWMU-11) will not be performed. After shut-down is achieved at SWMU-11, significant VOC mass will have been removed from both the soil and groundwater. Re-starting the SVE system (vapor extraction and/or groundwater recovery wells) will be considered, if it is cost-effective as compared to other remedial alternatives. Re-starting the SVE system will be discussed with USEPA, after these results have been evaluated.

Soil sampling will be performed at SWMU-11 to evaluate the effectiveness of the SVE system after the shut-down criteria for the SVE system has been met. The scope of this Phase II release characterization sampling task is detailed in Chapter 2 of the Stabilization Work Plan (1992). Soil will be sampled at selected SWMU-11 locations. Borings will be advanced and split-spoon samples will be collected from 2 feet below grade to the water table. The headspace of all soil samples will be screened in the field for VOCs. The results of this analysis will be used to select samples for laboratory analysis of target analytes.

4.5 SUMMARY

This chapter described the shut-down criteria and confirmatory sampling plans for the groundwater capture, groundwater pretreatment and SVE systems.

Groundwater Capture System

The final cleanup criteria for the groundwater capture system will be based on the MPS which will be developed during Phase II of the RCRA Facility Investigation. Confirmatory sampling of the groundwater capture system will be performed after the shut-down criteria for the groundwater capture system have been satisfied. Recovery wells and six monitoring wells will be sampled once every 2 months for the first 6 months after the groundwater capture system is shut down. Thereafter, these wells will be sampled semi-annually for an additional year.

Groundwater Pretreatment System

There is no shut-down criteria or confirmatory sampling plan for the groundwater pretreatment system. The groundwater pretreatment system will be operated as long as groundwater from the groundwater capture system and SVE system is being pumped. Shut-down periods for regular equipment maintenance or re-calibration, major equipment failure/replacement, or catastrophic system failures are possible. Routine shut-down periods of less than 4 to 6 months will not impact achieving the overall goals of the stabilization investigation.

Soil Vapor Extraction (SVE) System

The SVE system will be operated until either the concentrations of VOCs in the extracted soil vapor remain statistically flat for a six month period based on monthly soil vapor analytical data or until the VOC concentrations in groundwater remain statistically flat for a period of four sampling rounds.

Confirmatory sampling for the SVE system will not be performed after the shut-down criteria have been satisfied. There are no quantitative shut-down criteria for the SVE system.

Restarting of the SVE system (vapor extraction and/or groundwater recovery wells) will be considered if it is cost-effective as compared to other remedial alternatives. Soil at SWMU-11 will be sampled after the shut-down criteria are achieved. This sampling activity (Phase II Release Characterization) will evaluate the effectiveness of the SVE system.

The next chapter discusses the project management plan for stabilization.

Section 5

5.0
PROJECT MANAGEMENT

5.1 OVERVIEW

Project management ensures that all work necessary for the stabilization investigation will be completed in a timely fashion. A project management plan for the RCRA Facility Investigation was presented in Volume 1 of the RCRA Facility Investigation Proposal. That plan described the organization of the project and identified the tasks to be accomplished (including deliverable reports) as well as the schedule for completing those tasks. The project management plan was updated in Chapter 18 of the Phase I Interim Report and Phase II Proposal (submitted in November 1991), in Chapter 7 of the Phase II Pawtuxet River Proposal (submitted in January 1992), in Chapter 6 of the Stabilization Work Plan (submitted in August 1992), and in the Stabilization Investigation Report and Design Concepts Proposal (submitted in May 1993).

This chapter also updates (not replaces) the project management plan; it addresses project management issues only for the activities associated with the stabilization investigation, including:

- the project organization for the stabilization investigation (Section 5.2);
- the schedule for the stabilization investigation (Section 5.3); and
- contingency plans and other considerations for the stabilization investigation (Section 5.4).

Section 5.5 summarizes this chapter.

5.2 PROJECT ORGANIZATION

The project organization for this stabilization investigation ultimately reports to the USEPA and centers on the CIBA-GEIGY Project Coordinator who is responsible for: coordinating the interaction among all project participants, and ensuring that the objectives of the stabilization investigation are met. The organization structure for the stabilization investigation is presented in Figure 5-1. This organizational chart was revised (from Figure 6-1 of the Stabilization Investigation Report and Design Concepts Proposal) (May, 1993) to incorporate changes needed for the implementation phase of the investigation.

5.3 SCHEDULE

The stabilization investigation is on a separate schedule from the RCRA Facility Investigation being conducted at the site. This schedule is shown in Figure 5-2. This section discusses the two remaining components of the stabilization investigation: implementation and reporting.

5.3.1 Implementation Phase

The implementation phase of the stabilization program will start thirty (30) days after comments are received from the USEPA on the FSDD and all required permits and approvals for construction have been granted. In general, the implementation phase of the stabilization action will include:

- development of final construction bid package;
- advertisement of the contract documents;
- evaluation of the bids;
- award of contract;
- procurement of equipment;
- construction;
- start-up and testing;
- long-term operation and maintenance;
- monitoring; and
- preparation of future stabilization reports after the performance standards are met.

5.3.2 Stabilization Reports

During the implementation phase, information will continue to be delivered formally to the USEPA in the form of Monthly Progress Reports and major reports at key points during the stabilization investigation. This section discusses briefly the deliverables for each of these reporting mechanisms.

- Monthly Progress Reports - Activities performed as part of the stabilization investigation will continue to be discussed in the Monthly Progress Reports. These reports will be submitted on or before the 10th day of each month.

- Stabilization Reports - Delivered to the USEPA three months after the approved performance standards have been met in the Production Area.

5.4 CONTINGENCIES AND CONSIDERATIONS

The schedule for stabilization is very tight, so successful management and timely completion of this project depends on identifying two risk management procedures including:

- the *contingencies* that may arise and outlining plans to counter them; and

- *critical success factors* - those management issues that will "make or break" the successful and timely completion of the stabilization investigation.

5.4.1 Contingencies and Planned Responses

Five contingencies have been identified at this point for the stabilization investigation:

- permits to discharge pretreated groundwater from the groundwater pretreatment system to the POTW may be refused or delayed;

- permits to discharge treated air from the vapor-phase portion of the groundwater pretreatment system may be refused or delayed;

- permits to discharge treated air from the SVE system may be refused or delayed;

- other permits or approvals required for stabilization activities may be refused or delayed; and

- equipment procurement, delivery, and/or construction may be delayed.

These contingencies, and the plans for managing each, are discussed in this section. In addition, the assumptions for designing the stabilization measures also should be regarded as contingencies.

<u>Groundwater Discharge Permit for the Pretreatment System Refused or Delayed</u>

Discharge of pretreated groundwater from the pretreatment system to the City of Cranston POTW will require obtaining a new industrial wastewater discharge permit. Should the groundwater discharge permit be refused, CIBA-GEIGY will initiate negotiations with the City of Cranston to obtain the required groundwater discharge permit. Should the groundwater permit be delayed, CIBA-GEIGY will initiate weekly tracking of the permit approval process with the City of Cranston to ensure the required groundwater discharge permit is obtained as soon as possible. If unforeseen (or significant) delays are encountered in obtaining this permit from the City of Cranston, then the schedule for subsequent activities in the stabilization investigation will be impacted.

<u>Air Emission Permit for Pretreatment System Refused or Delayed</u>

Discharge of treated air from the vapor-phase portion of the groundwater pretreatment system will require obtaining an air emission permit from RIDEM. Should the air emission permit for the vapor-phase portion of the groundwater pretreatment system be refused, CIBA-GEIGY will initiate negotiations with RIDEM to obtain the required air emission permit. Should the air emission permit be delayed, CIBA-GEIGY will initiate weekly tracking of air emission permit approval process to ensure the required air emission permit is obtained as soon as possible. If unforeseen (or significant) delays are encountered in obtaining this permit, then the schedule for implementing the stabilization investigation will be impacted.

Air Emission Permit for Soil Vapor Extraction System Refused or Delayed

Discharge of treated air from the SVE system will require obtaining a separate air emission permit from RIDEM. Should the air emission permit for the SVE system be refused, CIBA-GEIGY will initiate negotiations with RIDEM to obtain the required air emission permit. Should the air emission permit be delayed, CIBA-GEIGY will initiate weekly tracking of the air emission permit approval process to ensure the required air emission permit is obtained as soon as possible. If unforeseen (or significant) delays are encountered in obtaining this permit, then the schedule for implementing the stabilization action may be impacted.

Other Permits/Approvals Refused or Delayed

A variety of other permits (e.g., construction permits) and approvals will need to be obtained for the implementation phase of the stabilization investigation. Because the nature and number of such permits/approvals, the time required to obtain permits/approvals may not be reflected accurately in the schedule. Every attempt will be made to minimize the routine delays encountered during permitting. However, any significant delays encountered in obtaining other permits/approvals will impact the schedule for the stabilization investigation.

Equipment Procurement, Delivery, and/or Construction Delayed

Equipment for the groundwater capture, pretreatment system and the SVE system will be ordered from several manufacturers/distributors and delivered to the site; the systems will then be constructed on-site. It is likely that some of the equipment will require a long-lead time to procure. To minimize potential impacts to the schedule, CIBA-GEIGY may prepurchase the long-lead items prior to award of the construction contract. Alternate equipment and/or suppliers will also be identified prior to construction. However, any significant delays encountered in equipment procurement, delivery, and/or construction will impact the schedule for the stabilization investigation.

<u>Assumptions for Designing the Stabilization Measures</u>

The following general assumptions were made during the design phase; these assumptions are also regarded as contingencies:

- POTW acceptance of groundwater discharge - It is assumed that the necessary permits/approvals will be obtained, and that the necessary procedures will be established, so that the POTW will accept pretreated groundwater. As discussed earlier, delays or refusals in obtaining permits and/or approvals will impact the schedule.

- Wells pumped will depend on field conditions - Field conditions may change before or during implementation of stabilization, so it is assumed that, if no response is observed at a well proposed for pumping, one or more new wells may need to be installed and tested.

- Trace constituents in the groundwater will not be problematic - During the stabilization pilot testing program, some constituents were detected occasionally and in trace concentrations; it is assumed that those constituents will not be encountered at concentrations that affect the ability of the pretreatment system to meet the required discharge limitations.

5.4.2 Critical Success Factors

Two critical success factors have been identified during the stabilization investigation including:

- vendor-supplied equipment must be delivered on schedule; and
- contractor-performed construction must be completed on schedule.

This section discusses these critical success factors.

Vendor-Supplied Equipment Delivery

Reliable equipment vendors must be identified for providing the equipment required and specified for the groundwater capture, the pretreatment and the SVE systems. Contractual penalties in the form of liquidated damages may be used to help ensure that vendors deliver the required equipment on schedule. However, if vendors supplying critical components of the full-scale systems fail to meet negotiated deadlines, the schedule for later stabilization phases could be impacted significantly.

Contractor-Performed Construction

Several reliable general contractors (and sub-contractors) must be identified for constructing the groundwater capture, the pretreatment and the SVE systems. Contractual penalties (liquidated damages) may be used to help ensure that contractors will meet negotiated schedules. However, if contractors constructing critical components of the systems fail to meet negotiated deadlines, the schedule for later stabilization phases could be impacted significantly.

5.5 SUMMARY

This chapter addressed project management issues for the stabilization investigation currently in progress at the former CIBA-GEIGY facility in Cranston, Rhode Island. The project direction for this investigation falls under the USEPA-Region I and the CIBA-GEIGY Project Coordinator. The current stabilization investigation and the Phase II activities for the RCRA Facility Investigation are on separate schedules. The schedule for the stabilization implementation phase is organized around the following group of activities:

1. Identifying reliable general contractors, including developing construction standards, developing a list of potential pre-qualified contractors, and evaluating and selecting contractors and subcontractors.

Five specific contingencies have been identified for the stabilization investigation:

1. permits to discharge pretreated groundwater from the groundwater pretreatment system to the City of Cranston POTW may be refused or delayed;

2. permits to discharge treated air from the vapor-phase portion of the groundwater pretreatment system may be refused or delayed;

3. permits to discharge treated air from the SVE system may be refused or delayed;

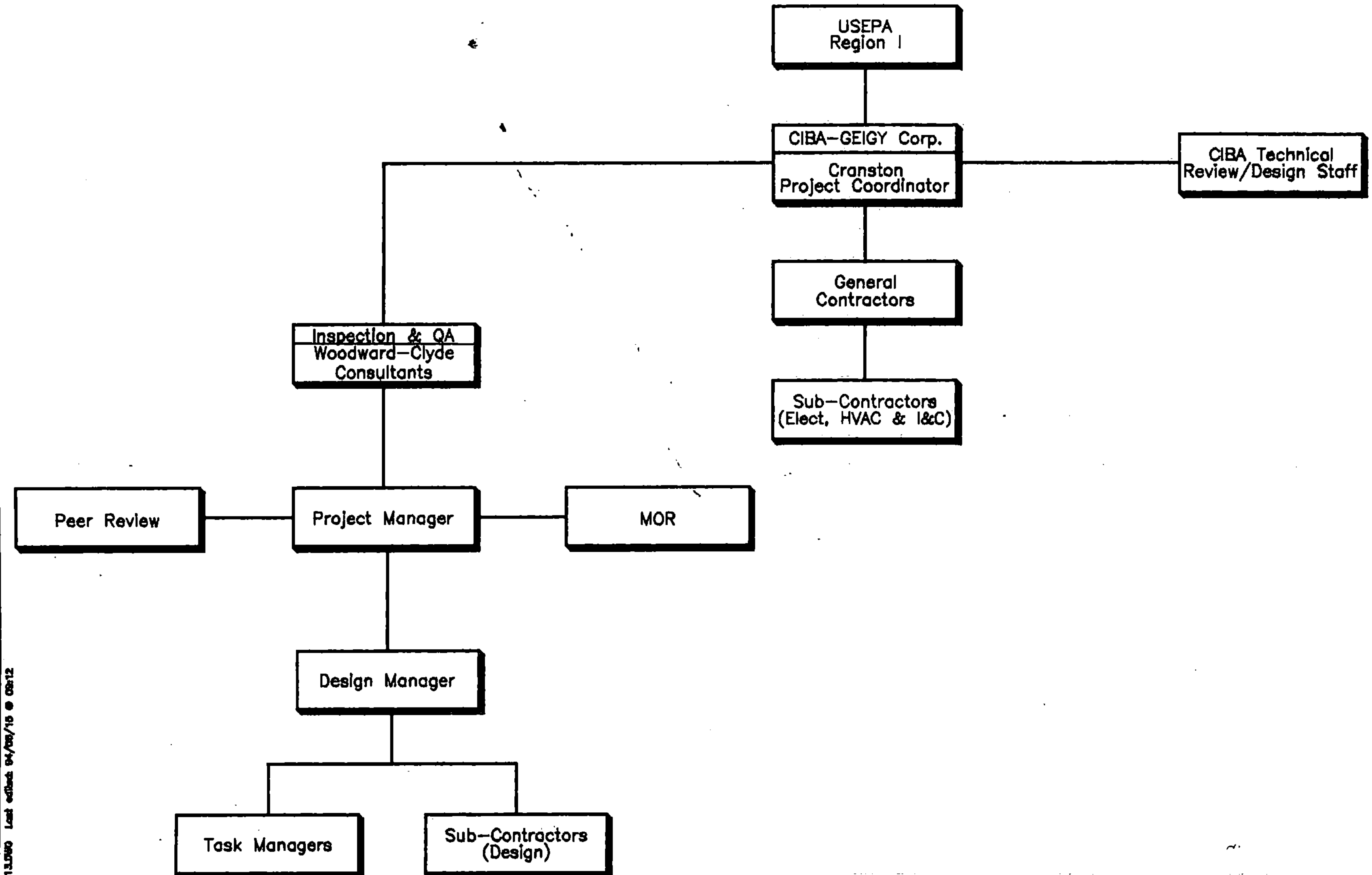
4. other permits or approvals required for stabilization activities may be refused or delayed; and

5. equipment procurement, delivery, and/or construction may be delayed.

Two critical success factors have been identified based on experience at the site:

1. vendor-supplied equipment must be delivered on schedule; and
2. contractor-performed construction must be completed on schedule.

Activities performed during the stabilization investigation will continue to be discussed in the Monthly Progress Reports. The Stabilization Report(s) will be prepared and submitted after the performance standards have been met.



PROJECT ORGANIZATION
STABILIZATION IMPLEMENTATION PHASE

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

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Stabilization Implementation Schedule

Former Ciba-Geigy Facility

Cranston, Rhode Island

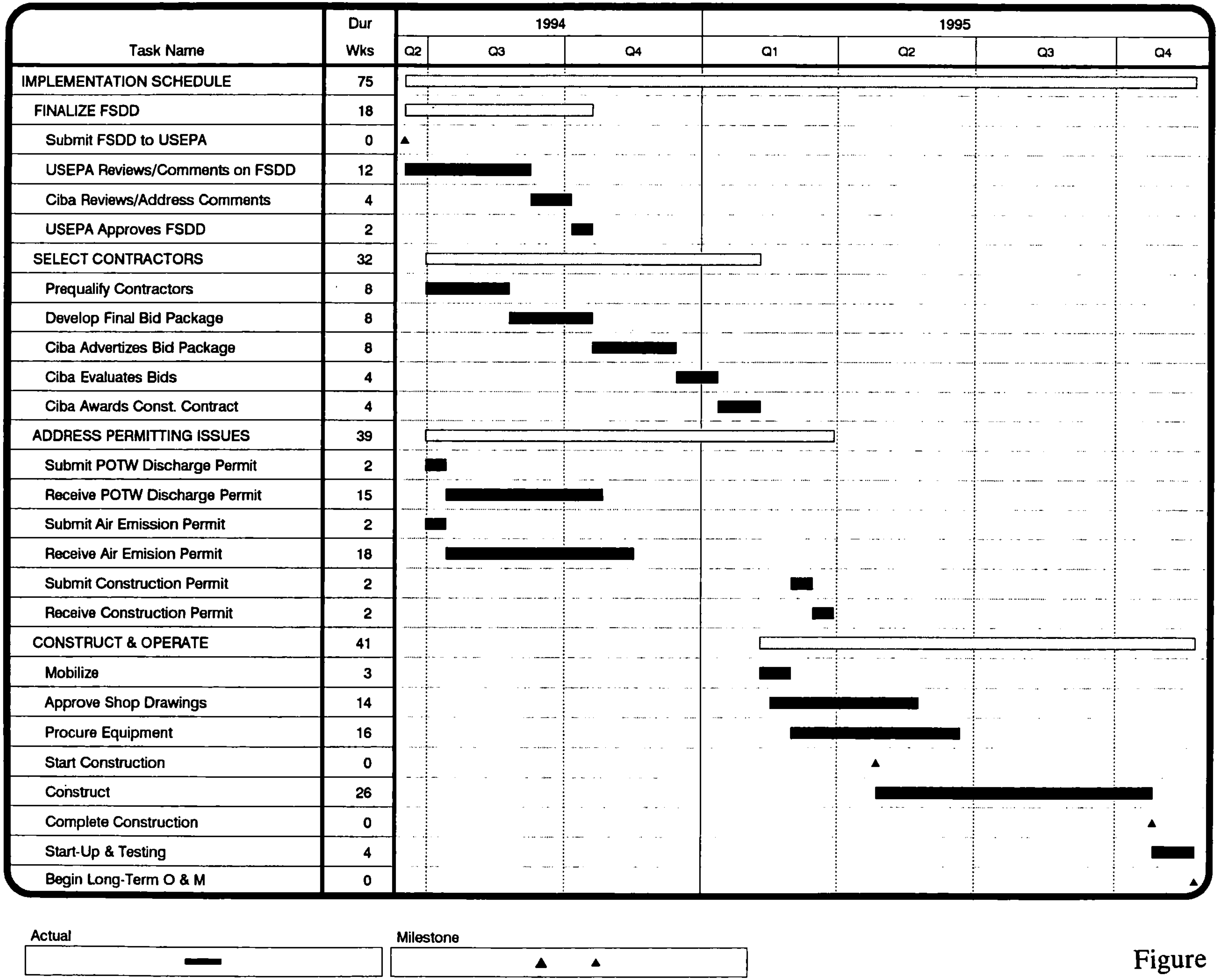


Figure 5-2

Appendix A

APPENDIX A
WELL CONSTRUCTION DETAILS: GROUNDWATER CAPTURE SYSTEM SOIL VAPOR EXTRACTION SYSTEM

This appendix presents the construction details for the groundwater recovery wells and soil vapor extraction wells. Up to four recovery wells will be installed at the bulkhead for the groundwater capture system (refer to Drawing G-2 of Volume 4). The soil vapor extraction system will include seven wells at SWMU-11. Four wells are designed to recover soil vapor and groundwater; three wells are designed to recover groundwater only.

The conceptual design of the groundwater capture system is based on the results of the aquifer testing program that was performed as part of the pre-design field activities. Data from the testing program are presented in the Stabilization Investigation Report and Design Concepts Proposal (May 3, 1993). The groundwater capture system is designed to limit the migration of groundwater into the Pawtuxet River by reversing the hydraulic gradient along the bulkhead in the Production Area. The soil vapor extraction system design is based on the results of the HIVAC pilot test (also discussed in the Stabilization Investigation Report and Design Concepts Proposal) and its ability to remove constituent mass from both the soil and groundwater at SWMU-11.

Section A.1 presents the construction details for existing groundwater recovery wells (PW-110 and PW-120) that were installed in the Production Area during the summer of 1993. Section A.2 presents the strategy for installing additional groundwater recovery wells and their proposed construction details. Section A.3 presents the construction details for the soil vapor extraction wells.

A.1. WELL CONSTRUCTION DETAILS FOR EXISTING GROUNDWATER RECOVERY WELLS

The groundwater capture system will include up to four recovery wells (PW-110, PW-120, PW-130 and PW-140) located 15 to 25 feet from the bulkhead (Figure A-1). Two of these wells

(PW-110 and PW-120) were installed during the field activities conducted in July of 1993. Additional recovery wells (PW-130 and PW-140) may be installed (if needed), after aquifer testing of PW-110 and PW-120 is completed. Figure A-2 presents the design of the existing recovery wells. Figure A-1 shows the location of this cross-section.

Recovery wells PW-110 and PW-120 were constructed as described in (Section 2.4.1) the Stabilization Investigation Report and Design Concepts Proposal. Soil borings were advanced at the selected well locations. Soil was sampled continuously from split-spoon samplers and logged; boring logs were presented in the DSDD. Soil sampling, drilling, and well installation activities were performed as described in the Quality Assurance Documents: Supplement (January 1992).

Selected split-spoon soil samples were analyzed in the field for grain size using 3-inch sieves. The results of the grain size analyses, were used to design the required sand pack and select the screen slot size for each well. The selected sand packs and screen slot sizes are shown in Figures A-3 and A-4 for recovery wells PW-110 and PW-120, respectively.

The recovery wells were designed to reverse the hydraulic gradient at the bulkhead with the minimum drawdown required. By minimizing the required drawdown, the potential for drawing contaminants vertically downward into less contaminated deeper units is reduced greatly. A description of each recovery well design is presented here:

PW-110: Recovery well PW-110 is constructed in the Fill, Gravelly Sand, and Fine Sand units (Figure A-2). These three units were determined to be fully hydraulically connected (when one unit is pumped, a drawdown response is noted in the other units) during aquifer testing. To create a cone of depression that extended into the boundaries of the Gravelly Sand unit, PW-110 was installed at a depth of 35 feet below ground surface, a depth that can sustain a constant pumping rate of greater than 40 gpm.

PW-110 does not create a pathway for the migration of constituents into the deeper Fine Sand unit. PW-110 does not penetrate a confining or semi-confining unit (the Silt unit is absent here as shown in Figure A-2) and the flow induced from the pumping of PW-110 will be horizontal within the aquifers, not vertically.

PW-120: Recovery well PW-120 is constructed in the Fill, Silt, and Fine Sand units (Figure A-2). To attain the minimum drawdown goals (10 gpm or more) along the southwest portion of the bulkhead, PW-120 had to be installed deep enough to sustain a constant yield. Based on the results of aquifer testing for RC-2, PW-120 was installed at a depth of 45 feet below ground surface.

PW-120 was constructed with two screened intervals (in the Fill unit and in the Fine Sand unit; see Figures A-2 and A-4) to limit the potential for the downward migration of constituents. The Silt unit is cased off to minimize the potential for the downward migration of constituents along the borehole (Figure A-2).

It should be noted that contamination in the deeper Fine Sand unit has been detected in the area of PW-120. This is based on the 48 foot deep Hydropunch sample in boring P-2D which is reported in the Stabilization Investigation Report and Design Concepts Proposal. As such, PW-120 will not cause a new migration pathway into the Fine Sand unit. PW-120, as constructed, will prevent further degradation and aid in constituent removal in the Fine Sand unit at this location.

A.2 PROPOSED ADDITIONAL GROUNDWATER RECOVERY WELLS

Up to two additional recovery wells (PW-130 and PW-140) may be required along the bulkhead if the drawdown from PW-110 and PW-120 is not sufficient to reverse the hydraulic gradient along the bulkhead. These wells are proposed at the approximate locations shown on Figure A-1. The need for one or two additional recovery wells will depend on the areal extent required and the amount of space along the central portion of the bulkhead where this gradient reversal is required.

The construction of PW-130 and PW-140 will be limited in depth to the bottom of the Fill unit as shown in Figure A-5. This construction is proposed so that a pathway for constituents is not introduced into the Fine Sand unit (which is essentially uncontaminated in these areas). However, this proposed construction does limit the areal extent of the cone of influence that will be attained by either PW-130 and PW-140.

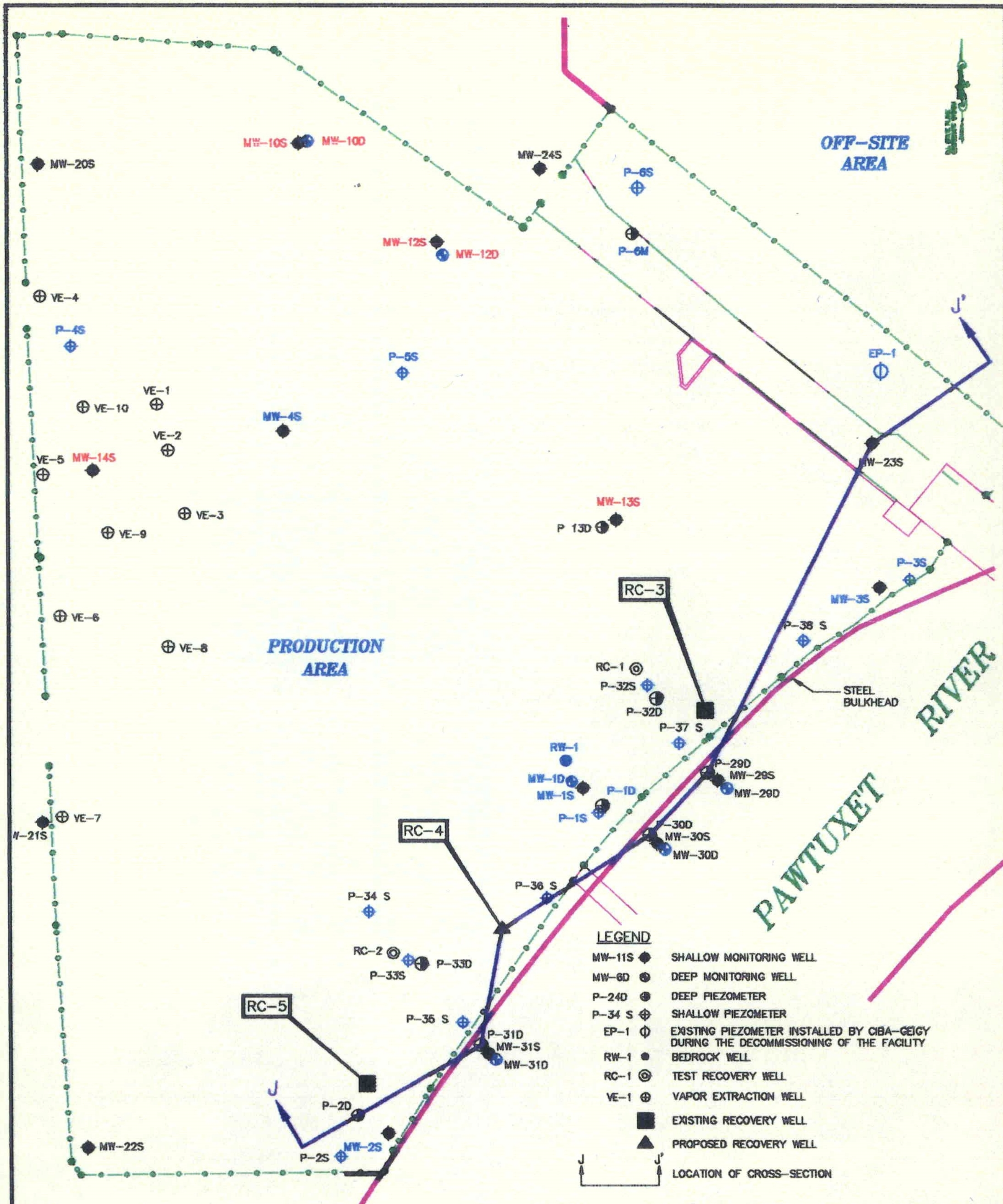
A.5 SOIL VAPOR EXTRACTION WELL CONSTRUCTION DETAILS

Seven extraction wells (VE-1, VE-2, VE-3, VE-7, VE-9, VE-10, and VE-11) are proposed for the SVE system. Four of these wells (VE-1, VE-2, VE-3, and VE-11) will extract soil vapor and groundwater. Three wells (VE-7, VE-9, and VE-10) will extract groundwater only. Six monitoring wells (VE-4, VE-5, VE-6, VE-8, MW-4S, and P-4S), which could be converted to soil vapor and/or groundwater extraction wells if needed, are also part of the SVE system.

Wells VE-2, VE-4, VE-5, VE-6, VE-7, VE-8, VE-9, and VE-10 were installed at a depth of 20 feet below the ground surface. These wells were constructed of 15-feet, 4-inch diameter 0.010 inch slotted PVC screen and 6-feet, 4-inch diameter PVC riser pipe. Each well contains about 16 feet of Morie #00 sand, a 1-foot bentonite seal, and is completed with a cement/bentonite mixture to the ground surface. VE-1 and VE-3 are constructed in the same manner but are finished with 2-inch diameter PVC. The soil vapor extraction wells are constructed with the screened interval at least 2 feet above the water table to maximize vapor recovery. Well screens generally extend through the entire saturated portion of the Fill unit.

VE-2 and VE-3 are located in an area containing free floating product (which was not discovered until after the wells were constructed). Since this product contains mostly toluene which degrades the integrity of PVC, it may be necessary to replace VE-1 and VE-2. Also, since VE-3 is only 2-inches in diameter, (not wide enough to fit the SVE system controls), it is also necessary to replace VE-3. These wells will be replaced by VE-1R, VE-2R, VE-3R (to be constructed within 3 feet of VE-1, VE-2, and VE-3). The replacement wells will be constructed of stainless steel to minimize the potential for the degradation of the PVC due to the presence of free product. Other construction details are the same as previously described.

The other wells in the SVE system, VE-11 (formerly MW-14S), MW-4S, and P-4S were installed as monitoring wells during Phase I field activities. Their construction details are presented in the RCRA Facility Investigation Interim Report (November 20, 1991).



PROPOSED RECOVERY WELL LOCATIONS FOR THE FULL-SCALE GROUNDWATER CAPTURE SYSTEM

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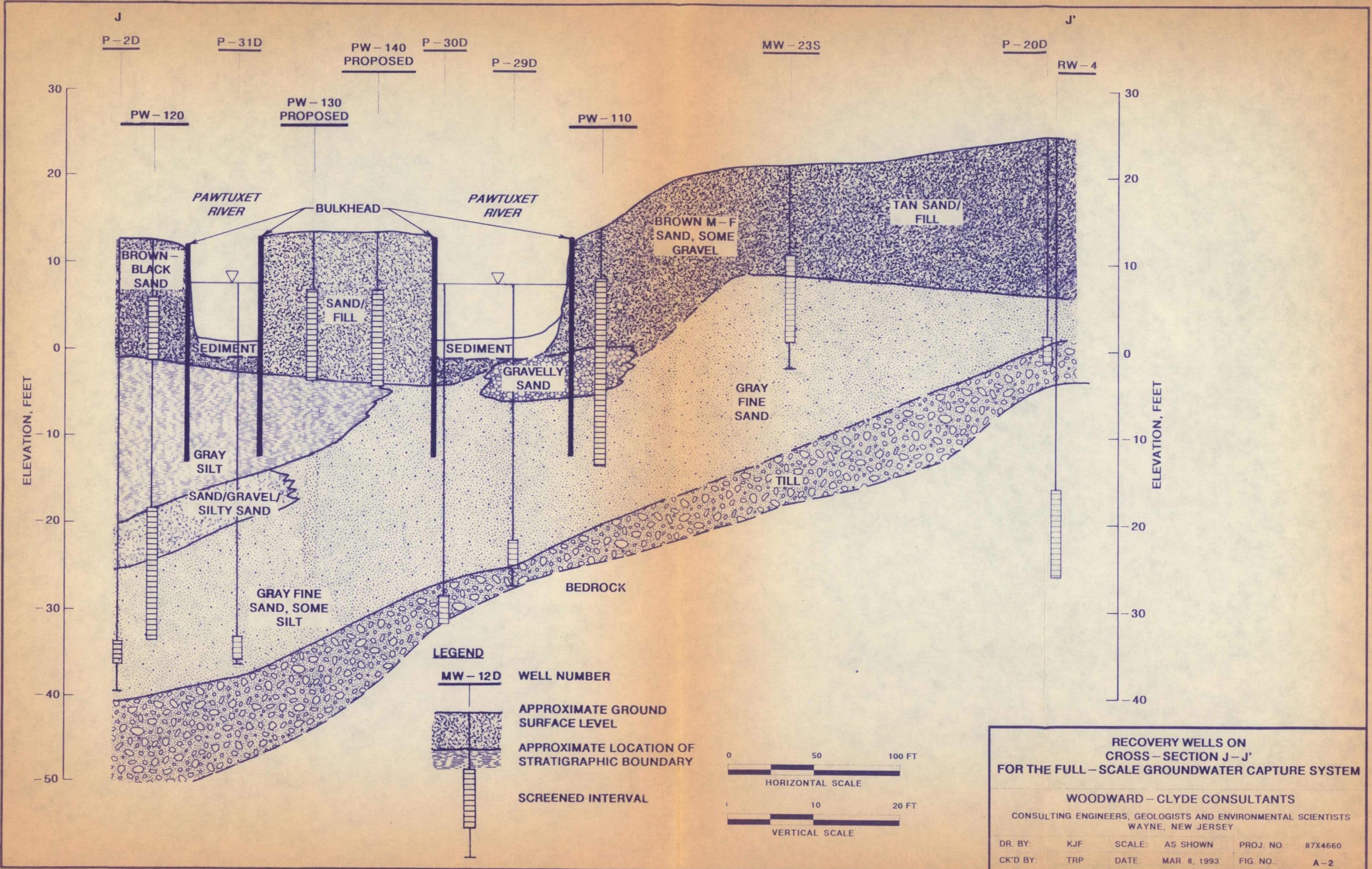
WAYNE, NEW JERSEY

DR.BY	BTM	SCALE	1 : 720	DWG.NO.	FIGA-1	PROJ.	87X4660
CK'D.BY	TAM	DATE	APRIL 11, 1994	FIG.NO.	A-1		



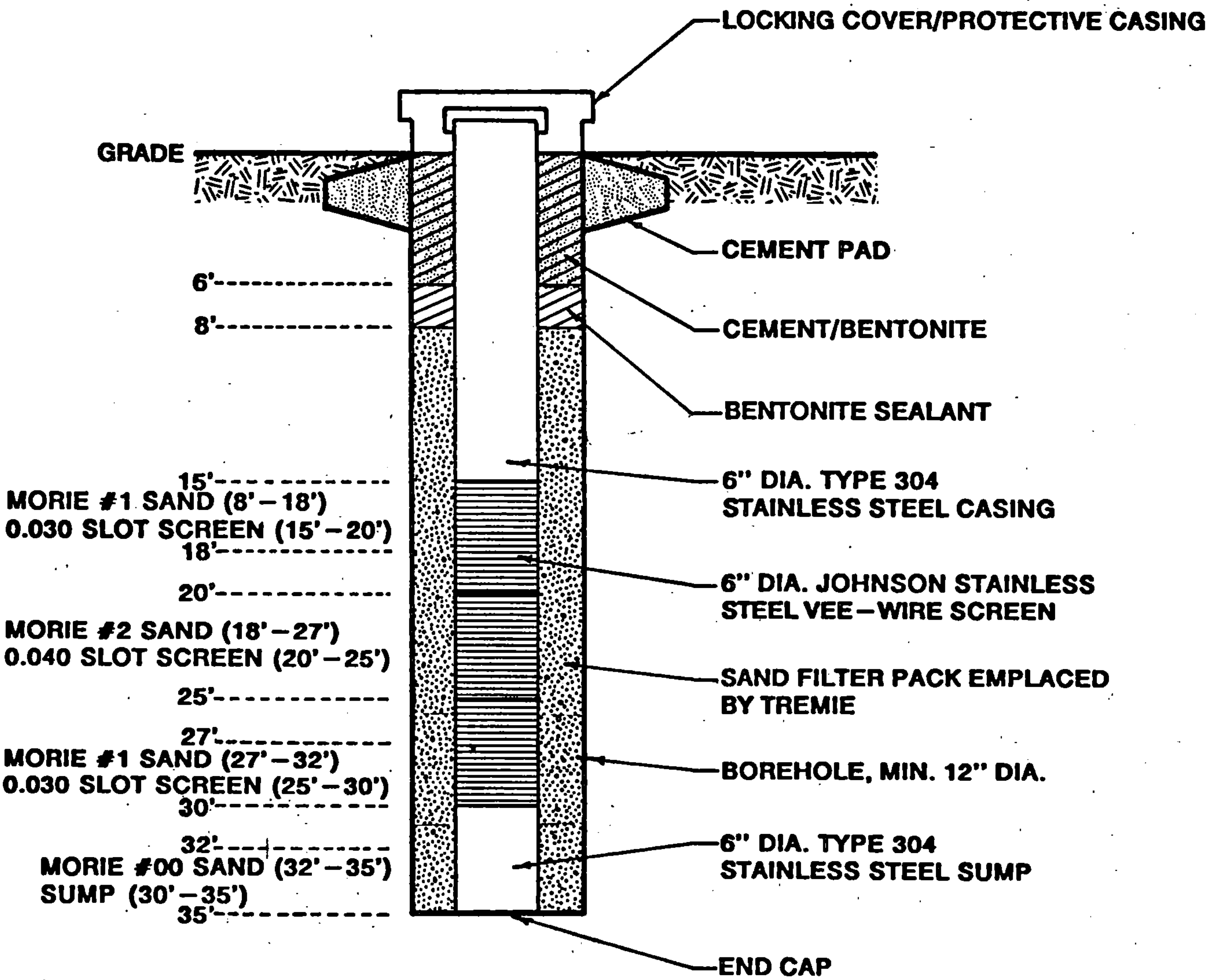
RECOVERY WELLS ON CROSS-SECTION J-J' FOR THE FULL-SCALE GROUNDWATER CAPTURE SYSTEM

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY:	KJF	SCALE:	AS SHOWN	PROJ. NO.:	87X4660
CK'D BY:	TRP	DATE:	MAR 8, 1993	FIG. NO.:	A-2

WELL CONSTRUCTION DETAILS (AS BUILT)
PW-110



0 8 16 FT

VERTICAL SCALE

HORIZONTAL NOT TO SCALE

WELL CONSTRUCTION DETAILS PW-110

WOODWARD-CLYDE CONSULTANTS

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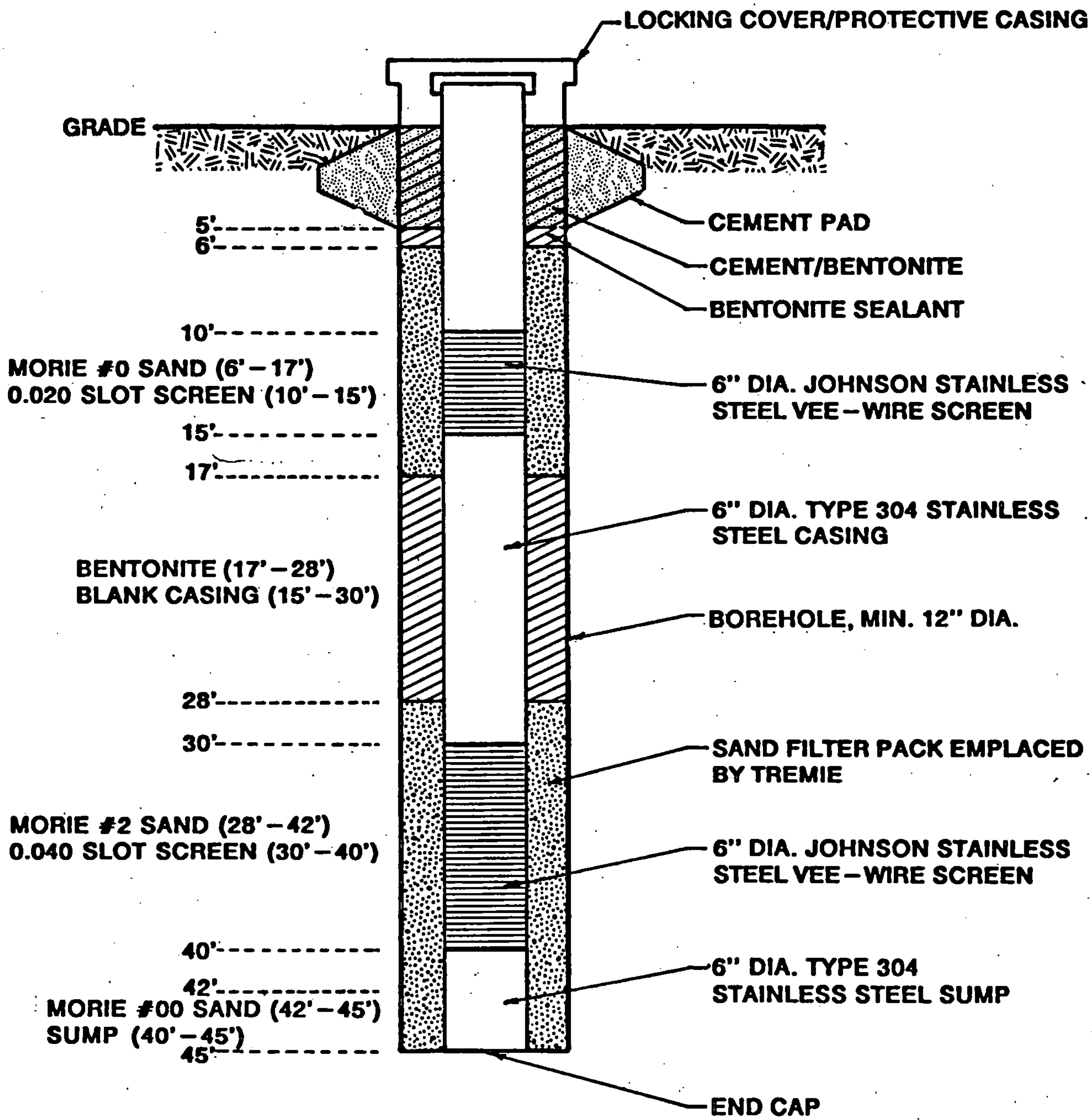
WAYNE, NEW JERSEY

DR. BY:	KJFH	SCALE:	AS SHOWN	PROJ. NO.:	87X4660
CK'D BY:	TRP	DATE:	OCT. 25, 1993	FIG. NO.:	A-3

WELL CONSTRUCTION DETAILS (AS BUILT)
PW – 120



VERTICAL SCALE

HORIZONTAL NOT TO SCALE

WELL CONSTRUCTION DETAILS PW – 120

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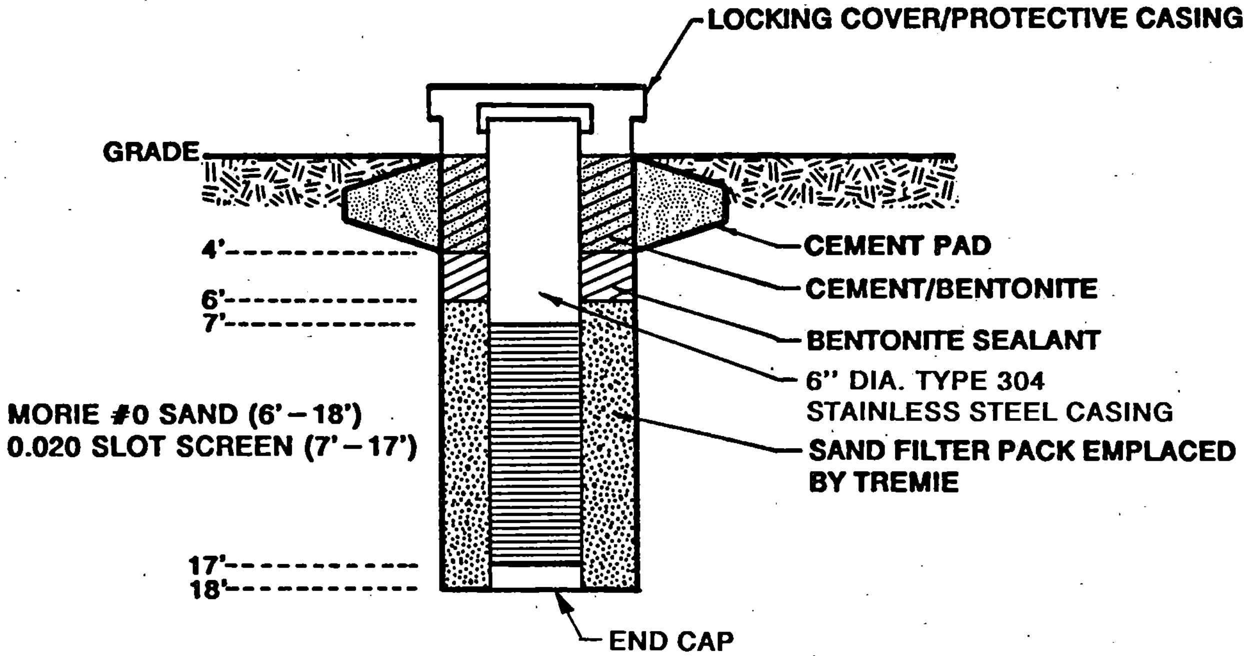
WAYNE, NEW JERSEY

DR. BY:	KJFH	SCALE:	AS SHOWN	PROJ. NO.:	87X4660
CK'D BY:	TRP	DATE:	OCT. 25, 1993	FIG. NO.:	A – 4

WELL CONSTRUCTION DETAILS (PROPOSED)
PW – 130 and PW – 140



VERTICAL SCALE

HORIZONTAL NOT TO SCALE

PROPOSED WELL CONSTRUCTION DETAILS

PW – 130 AND PW – 140

WOODWARD – CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY:	KJFH	SCALE:	AS SHOWN	PROJ. NO.:	87X4660
CK'D BY:	TRP	DATE:	OCT. 25, 1993	FIG. NO.:	A-5